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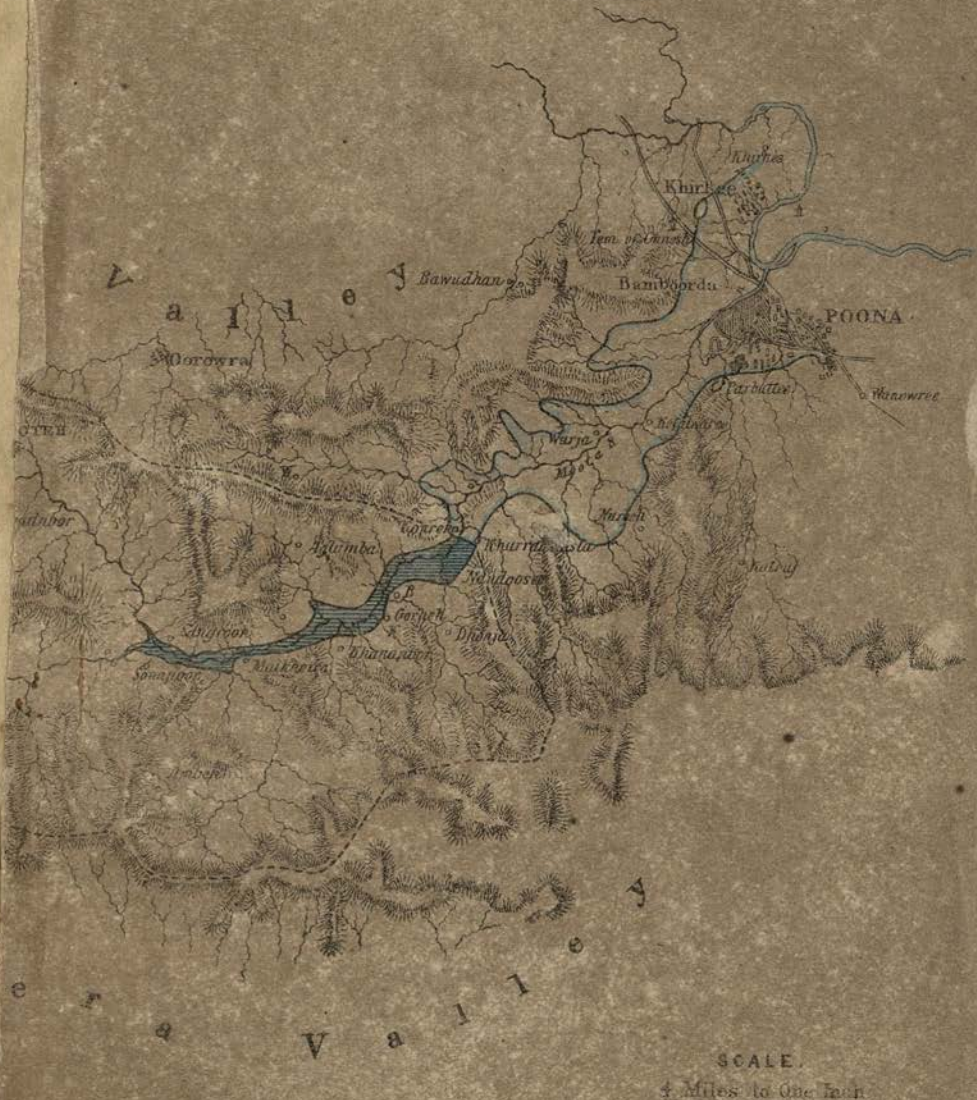
Khurkee
Bawudhan
Bumboordu
POONA
Warja
Khurrukwasla
Dhanajee
Sonapoor
Malkhera
Jamboli
SCALE.
4 Miles to One Inch

SELECTIONS FROM THE RECORDS OF THE BOMBAY GOVERNMENT.

IRRIGATION SERIES.—No. II.

WATER SUPPLY

OF

POONA AND KIRKEE

WITH

PLANS AND ESTIMATES.

PROJECT

BY

LIEUT. COL. FIFE, R.E.

With a Map, and 2 Lithographed Drawings in a Separate Case.

(Copies of the remaining Plans to be had separately.)

Bombay:

PRINTED FOR GOVERNMENT

AT THE EDUCATION SOCIETY'S PRESS, BYCULLA.

1866.

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No. 860 A OF 1865.

PUBLIC WORKS DEPARTMENT:

OFFICE OF THE SUPERINTENDING ENGINEER FOR IRRIGATION,

Poona, 30th November 1865.

To Lieutenant Colonel SCOTT,

Superintending Engineer, S.D.

SIR,—With reference to Government Resolution No. $\frac{536CW}{1504}$ dated 13th July 1865, I have the honour to submit Plans and Estimates, the latter amounting to Rs. 16,53,049, for the Water Supply of Poona Cantonment, Kirkee Cantonment, the New Arsenal and Powder Works at Kirkee, and Poona City, with its environs.

2. Before entering upon a description of the works it will be desirable to give a brief sketch of the various projects which have been brought forward from time to time during a long course of years to improve the water supply of Poona and Kirkee.

3. The supply of water to Poona has always been a difficulty, and in 1848 the Jamsetjee Bund across the river Moolla Moota was constructed, and machinery erected for pumping what was then considered a sufficient quantity of water up to the Cantonment. How very imperfectly this work has supplied the deficiency is well known to Government and all residents at Poona, and the lucid report of the 5th September 1865, by Dr. Leith, the President of the Sanatory Commission, has most completely proved the utter hopelessness of our ever obtaining a supply of pure water from that source.

4. In 1856, after the Jamsetjee Bund Works had been eight years in use, the inadequacy of the water supply was so severely felt that Government appointed Captain Hart to the special duty of drawing up a project for entirely new water works. Captain Hart, after carefully examining the country about Poona, drew up a project for a reservoir at a place called Ambegaum, and leading the

water thence by a conduit and pipes for a distance of nearly 9 miles, to Poona. This project was very complete for the quantity of water it was then contemplated to supply, and the cost was estimated at Rs. 5,34,163.

5. But two questions have since been raised which vitally affect the project; the one as to the quality, the other as to the quantity, of water. It has already been observed of the Vehar Lake, which supplies Bombay, that the quality of the water seriously deteriorates during the hot season, and it is known to all who have had any experience of tanks in this country, that the small ones, except they be those beautiful masonry works, like large wells, and supplied by springs, which are to be seen occasionally in different parts of the country, become so foul under the effect of a tropical sun and long drought, that they are unfit for domestic purposes. The Ambegaum tank or reservior has an extreme depth of 53 feet at the deepest part, and its bed slopes gradually upon all sides, so that a great deal of the water is comparatively shallow. Its whole content is 48,154,093 cubic feet, and its area is 77¾ acres nearly, while the Vehar Lake contains 1,592,236,889 cubic feet, and has an area of 1,319¼ acres. The Ambegaum reservoir therefore would be only $\frac{1}{17}$th the size of the Vehar Lake, and its mean depth would be 13·55 feet less. If, therefore, impurity is complained of in the Vehar Lake, how much worse will be the Ambegaum Reservoir? There is no doubt that in so small a tank, which from its situation on a small stream stands but little chance of replenishment for long periods, the water in April and May, when the tank has become two-thirds dry, would become most impure, and as it is at this period of the year that the water difficulty is greatest in Poona, the matter would be very serious indeed.

6. Next as regards quantity. In 1856, Captain Hart calculated the requirements of the Poona Cantonment at 821,917 gallons per day, but so largely has the population increased since that time that Dr. Leith now shows most clearly that our works should supply 1,500,000 gallons a day. This large addition to the quantity of water not only makes the estimate which amounted to Rs. 5,34,163, prepared by Captain Hart, inapplicable, but necessitates the preparation of an entirely new project, the whole drainage area supplying

the Ambegaum Reservoir being insufficient to meet the extra demand. In Captain Hart's project the quantity of water that could be obtained from the Ambegaum drainage area was very nicely balanced with the demand, but now that the demand is so much increased, the quantity obtainable falls far short of the requirement. The original estimate prepared by Captain Hart amounted to Rs. 5,34,163, which would now have to be increased to Rs. 7,56,181, to cover the rise in prices since 1856. To supply the full quantity of water now considered necessary for Poona Cantonment, the cost would be about Rs. 14,17,840, supposing that a larger basin and drainage area affording about the same facilities for the works as at Ambegaum could be found.

Kirkee Cantonment.

7. The Cantonment of Kirkee has recently been shown by Dr. Leith to be actually, if possible, in a worse position than Poona as respects good water, but less has been heard of the hardship from the station being so much smaller. The want was, however, far too serious to be passed over without some enquiry being set on foot to supply it, and we find that in 1853 Captain Berthon, and, again in 1857, Captain Hart, investigated the subject. It was found that water was obtainable in a small quantity from springs in the Pashan Nullah at a distance of about 5 miles from the station, but no regular plans were prepared. The subject remained in abeyance till 1863, when the constant complaints that reached Government of the deficiency of the water supply, and the proposal to locate at Kirkee the new Powder Works and Arsenal, led to instructions being issued to myself to draw up plans for supplying water for all purposes. This was accordingly done, and complete plans were drawn up to supply 1,84,920 gallons a day at a cost of Rs. 2,73,238.

8. This project had however hardly been prepared when fresh demands arose. It was found that the road between Poona and Kirkee was being lined with new houses, and that buildings had commenced to the west of the City of Poona on ground which before appeared as if it never would be occupied. Soon after this it was found that the estimate of water requirements for the Powder Works was not applicable in consequence of the Engines being condensing instead of noncondensing ones, and that an enormous in-

crease must be made to the water supply. Finally, it was determined to locate the Sappers and Miners at Kirkee as well as the Artillery, and it is now I believe almost certain that a European regiment will be added to the Garrison. The quantity of water provided for in the Kirkee water supply project was 1,84,920 gallons a day, and the estimated cost Rs. 2,73,238. The quantity of water now required by Government Resolution No. $\frac{213MW}{1733,}$ dated 10th August last, is 9,34,665 gallons a day, the cost of which, on the same plan, has been approximately estimated at Rs. 6,91,339.

The City of Poona.

9. The supply of water to the City of Poona has always been defective, and though the proverbial public spirit of wealthy natives in constructing wells and conduits has done almost everything that could be done, a very large portion of the population is still dependent on the river for water, and as the stream ceases to flow in February, the people take the water from stagnant pools or pits excavated in the bed. The water obtained from the latter would be pure in any open part of the river, but at the City, where both banks are crowded with houses, and every sort of filth finds its way down to the river bed, the water cannot be pure, and the quantity is moreover very small, as the Moota, like most of the Deccan rivers, has rock close under the bed, and in places the bed itself is rock. During a drought which occurred about 30 years ago, the people were reduced to such a condition of distress that they excavated a cut in the river bed to tap some pools situated about 12 miles off. During the past season an attempt was made by the Public Works Department to bring water down to the city in the same way, and it was of some use.

10. The City of Poona has not enough water for ordinary purposes. Much less does the supply suffice for sewage; for which, practically speaking, there is none at all except during heavy rain. Government has already been made acquainted with the condition of the sewers from a report dated 8th August 1865, submitted by a Committee composed of Dr. Leith, Mr. Duff the Collector, and myself. It was found by the Committee that the present sewers were choked up from the proportion of solid matter finding its way into them being too great, and that they were in fact nothing more than

elongated cesspools, polluting the ground in every direction. To improve the sewage was simply impossible without a copious supply of water, such as is afforded to European cities.

11. No project was ever prepared for affording Poona an adequate supply of wholesome water, but it is probable that the city, with a population of 70,000, will require as much water as the Cantonment, or 1,500,000 gallons a day, to supply which would cost a very large sum indeed, though not so much as in the case of the Poona Cantonment, the elevation of which is greater, and consequently the facility for water supply works less. It may answer for the present to assume that the Poona City water supply, if carried out on the Ambegaum plan, would cost two thirds as much, or Rs. 9,45,226 for 1,500,000 gallons per day, or, exclusive of minor distribution pipes, Rs. 7,19,846.

12. Briefly summarizing the history of the question of the water supply of Poona and Kirkee, and of the City of Poona, it appears then that the supply of wholesome water has always been inadequate, and that the increasing population, with the location of the Powder Works and Arsenal at Kirkee, has rendered it now imperative that water works should be at once undertaken.

2nd. That the cost of affording an adequate supply on the small tank and pipe system will be as follows :—

Poona Cantonment—1,500,000 gallons per day ...	Rs.	14,17,840
Kirkee Cantonment and Powder Works—934,665 gallons per day	„	6,91,339
Poona City—1,500,000 gallons per day.....	„	7,19.846
Total probable cost.....	Rs.	28,29,025

3rd. That the water which will be obtained will be of inferior quality in the hot season, when the reservoirs sink to a low level.

13. Government must, I feel sure, have expected that, as I was appointed for the special duty of improving the water supply of the country for irrigation, and had also the disposing of many questions connected with the water supply of Poona and Kirkee, that I should look very carefully into the whole question, and suggest any better general plan than the separate ones which have from time to time been

brought forward, and at the Public Works Conference lately held at Poona I took the opportunity of explaining that the condition of the question was now such, that it would be infinitely more economical and better in every respect, to carry out one large project to supply all demands in both the Poona and Kirkee cantonments, and Poona City.

14. The project I am now about to describe will therefore not be quite new to Government, nor, I may add, is it really new at all as far as the source of supply goes, but it is on a larger scale than the projects formerly brought forward, and it is principally owing to this increase in size that, after the most careful investigation of the whole question, I have been led to revert to a source of supply that was formerly rejected. This source of supply is the river Moota itself, but at a distance of 11 miles above Poona, a locality thought of so far back as 1855, and strongly urged by the late Honorable Mr. Reeves, as most suitable for the purpose.

15. The feasibility of obtaining water from the Moota was considered by Captain Hart in his investigation of the water supply for Poona Cantonment, but the plan was rejected by him in consequence of the want of slope that would be available for the pipe from the river to Poona. For a project to afford the comparatively small quantity of water then contemplated, Captain Hart was right in his conclusion, but the question has now assumed a different aspect. What Captain Hart had to decide was the best means of obtaining 821,917 gallons a day, what has now to be decided is the best means of obtaining 3,000,000 gallons per day, with a demand for much more, if it can be furnished, for garden irrigation in the vicinity of Poona, where the extensive European and Native population creates a large demand, I may even say a necessity, for garden produce. Under this altered aspect of the question it appears that our best plan will be to revert to the Moota River as a source of supply, to form one large reservoir upon it, and to lead the very large quantity of water required by open ducts (for which the available slope is sufficient), to expense reservoirs in the vicinity of Poona and Kirkee, whence iron pipes will distribute the water for the various purposes for which it is required. The advantages of this plan are the greater facilities for storing and conveying a large supply of water, and consequently

greater economy ; and the greater purity of the water obtained from a reservoir, which, it will be hereafter explained, is never to be less than 50 feet deep opposite the reservoir dam. With these prefatory remarks I may now proceed to a description of the project.

The Reservoir.

Sheet No. 1.

16. The site selected for the reservoir is immediately above the village of Kurrukwasla, where the slope of the valley, 6 feet per mile, and the rocky nature of the ground, afford the requisite facilities for obtaining a large capacity for the reservoir, and perfect security from accident for the masonry impounding dam and the waste weir.

17. From the level of the stream being rather low at this point, and from the necessity for making allowance for silt deposit, as well as to avoid the necessity of completely draining the reservoir to obtain the whole quantity of water required, the feeding level to the ducts which have to lead the water to Kirkee and Poona has been fixed at 65 feet above the lowest part of the bed of the river, and about 40 feet above the banks. At this level the area of the reservoir will be 3 square miles.

18. The loss by evaporation in this large reservoir during 6 months, after which replenishment will take place from the showers at the commencement of the monsoon, has been taken at 5 feet perpendicular, and to provide for the whole quantity of water, 715,392,000 cubic feet, to be furnished during the 6 months of perfectly dry weather, the dam is to be 20 feet above the level of the feeding point. The area of the lake at this level will be $5\frac{1}{4}$ square miles. Its average width will be two-thirds of a mile, its average depth 36 feet, and it will be $7\frac{1}{2}$ miles in length.

19. The Dam will thus be 85 feet high at the deepest part of the valley, or where it crosses the river. Only 400 feet in length will however be of this height. The remainder varies from 60 feet at the bank of the river to almost nothing where the dam is connected with the hills on both sides of the valley. The dam is to be of masonry, and to check leakage a bank of earth will be added to its base on both sides. It will be founded on rock throughout its whole

length, and is of such a massive construction as to entirely set at rest any fear of such a catastrophe as occurred at Sheffield. The masonry dam, as will be seen from the calculations given in Appendix A, is in excess of what is required to resist the pressure of the water when the reservoir is filled up to the highest possible level, or when there is a stream 5 feet deep running over the waste weir. The total length of the dam is 2,900 feet, and the average height 48 feet.

20. *The Waste Weir.*—The waste weir is one of the most important portions of every water supply project, and in the present case, when the works are to be on a large scale, more than ordinary care and attention have been bestowed upon it. The heaviest flood which has been observed during the past two years, during which the state of the river has been daily guaged and registered, amounted to 45,405 cubic feet per second, but from reliable information obtained from the villagers of Koprah, whose village stands on the bank, it has been found that during an extraordinary flood which occurred in 1861, the river rose 6 feet higher than our guage indicated during the past two years. The flood discharge on that extraordinary occasion has been carefully calculated, and amounts to 82,079 cubic feet per second. The waste weir has been designed to discharge this volume. It is true that with the large reservoir the effect of a flood must be modified, and that instead of rushing past Koprah with a discharge of 82,079 cubic feet per second, and lasting at that height only an hour or so, it will raise the level of the water in the reservoir gradually, and escape by the waste weir in a smaller quantity per second, but will last many hours. Still, to be on the safe side in this important matter, it is better to give the waste weir dimensions, which will enable it to discharge the greatest flood that has ever been known to occur with the river in its present unobstructed state.

21. The waste weir provides for the escape of 82,079 feet per second, and the control of so large a stream as this has been very carefully studied. We have not been contented by an appearance of rock where the overfall will occur, but have actually blasted portions away at intervals all along the site, to be quite sure that the rock is really solid and sound, and not a mere superficial covering

to some softer stratum below. A defect in the rock would certainly not cause a catastrophe, but it would cause a leak, which would allow the water to be wasted in the first instance, and it would afterwards lead to a great deal of trouble and expense for repairs. I am glad to say, however, the result of the examination of the rock has proved satisfactory. After removing from one to five feet of the surface it has proved perfectly sound, and the bed extends from the waste weir site to a nullah in rear, and thence to the river bed again, at a distance of 1,200 feet below the dam. The nullah forms the depression by which the waste water will find its way back to the river again. The water is prevented from spreading towards the dam by means of a massive wing wall as strong in construction as the dam itself. The waste weir has an average height of 9 feet, and is 1,660 feet long. The water will flow 5 feet deep over its crest during the heaviest floods. Calculations for this work will be found in Appendix B.

22. *The Ducts.*—For Kirkee the ducts will have a slope of one foot per mile, a bottom width of 5 feet, depth 2½ feet, velocity of current 1·4745 feet, and the theoretical discharge of 32·2775 cubic feet per second. This duct will supply 26 cubic feet per second for the irrigation of 4,000 acres of land, and 1·75 cubic feet per second, or 934,665 gallons per day for Kirkee, the quantity fixed by Government Resolution No. $\frac{213MW}{1733}$ dated 10th August 1865. The duct will be of uniform size, that a week's supply for Kirkee may be carried in a few hours to the expense reservoir in order that the water may not sustain injury from passing in a slender stream along an open channel. The length of the duct will be 16 miles, as the unevenness of the ground makes the route circuitous. At that distance from the head works, settling and expense reservoirs are provided on the high ground opposite to Kirkee hill, with a command of 37·08 feet over the European Barracks and 25·72 feet over the highest delivery point in the Powder works on Kirkee Hill. The water will be conducted from the reservoir by means of an iron pipe varying from 14 inches in diameter in the portion from the reservoir to the Barracks, to 12 inches in diameter at the delivery point at the Powder Works. Smaller branch pipes distribute the water from the

main pipe. The main pipe passes over the ground which will be occupied by the proposed Fort.

23. There is nothing in the nature of the works on this duct which demands any great explanation. All drainage is passed under the duct by aqueducts and culverts, in exactly the same manner as in the irrigation works constructed in Khandeish. The water will be admitted into the duct from the reservoir by a simple sluice, the head of water to contend with being only 12 feet. The settling and expense reservoirs on the hill opposite Kirkee will contain one week's supply, and are formed in a small depression close to the water shed. The water is retained on the low side by a masonry wall backed with earth, and the bed of the reservoirs will be rock, all the overlying soil being scraped away.

24. On the Poona side of the river less fall is available than on the Kirkee side, and the slope of the duct is therefore only 6 inches per mile. The bottom width will be 10 feet, the depth 3 feet, the velocity 1·2023 feet per second, and the theoretical discharge 52·30 cubic feet per second. This discharge provides for 2·75 cubic feet per second, or 1,500,000 gallons per day for Poona Cantonment (the quantity fixed by Dr. Leith), 1,500,000 gallons per day for Poona City, and for 2,000 acres of irrigation.

25. As in the Kirkee duct there is no diminution of section towards the tail, and for the same reason, viz. that the water may be run off from the great reservoir to the expense reservoirs for Poona Cantonment and city in a few hours.

26. The Poona duct will be altogether 11½ miles in length. At the 9th mile it passes the Parbuttee Tank, which it commands. This tank is invariably dry when there is a great scarcity of water, but may now be used as an expense reservoir by the Municipality of Poona. It is unnecessarily large, but a portion may be easily shut off so as to form a reservoir of the requisite size. The Parbuttee Tank commands the whole of the city, hence the distribution of the water throughout the city by means of pipes will be a matter of no difficulty.

27. At the 11½ mile, or termination of the duct, two quarries now used as tanks, and situated near St. Mary's Church, are entered. The first one will have a retaining wall, averaging 5 feet in height,

built round it, and will be used as a settling reservoir. The second will have its lower edge raised 6 feet by a masonry wall, and it will then hold a week's supply of water for the Cantonment. The water will be distributed from this reservoir to the Bazar, Native Infantry Lines, Civil Lines, and Ghorepooree, by iron pipes and gravitation. For the Wanowree Lines, now occupied by H. M.'s 33rd Regiment, the water, if distributed through the Barracks, must be raised by machinery, and this is provided in the estimate. The quantity of water to be raised is 300,000 gallons per day, and the cost of raising it 90 feet capitalized is Rs. 85,600.

28. There is nothing in these works which demands any particular explanation. The drainage will all be passed under the duct. Fencing is provided for both sides of the duct when it gets near Poona, that people may be prevented from drawing water directly from it. At the expense reservoir side-chambers are provided for the people to draw water from, that there may be no necessity for taking water direct from the reservoir. All natural drainage will be be excluded from the reservoirs.

29. The cost of the works for the whole project will be as follows:—

		Rs.	a.	p.
Main reservoir dam with waste weir and sluices	Rs.	9,52,121	14	9
Kirkee open duct	,,	78,458	6	4
,, settling and expense reservoirs	,,	16,642	3	1
,, main pipe	,,	1,06,831	8	4
,, distribution pipes in Powder Works	,,	56,277	0	0
,, distribution pipes for Cantonment	,,	24,795	0	0
Poona open duct	,,	1,22,000	2	2
,, settling and expense reservoirs	,,	23,887	8	0
,, cisterns	,,	41,646	0	0
,, main pipe	,,	32,358	14	4
,, distribution pipes by gravitation	,,	79,129	13	8
,, steam power for raising water	,,	94,600	0	0
,, distributing pipes for Wanowree Lines	,,	24,301	4	0
Total	Rs.	16,53,049	10	8

30. This estimate, it will be observed, provides for both supplying and *distributing* the water in the most complete manner, but as our present position is one of absolute want of water, it would be a great boon to merely have the water brought into Poona and Kirkee to central reservoirs, whence it might be conveyed by carts and bullocks as at present practised from wells, leaving the more perfect distributing arrangements to be carried out afterwards, as rapidly as funds may be available. The distribution through the Powder Works is however essential immediately, as also a pipe to lead the water from the central reservoir in Poona to the Ghorepooree Lines. The remainder may be easily deferred. If, therefore, Government should prefer for the present to simply obtain an abundant supply of good water, which will be at least within reach of all the inhabitants, but not distributed in detail except to the Powder Works and Ghorepooree Lines, the estimate will become as follows :—

		Rs.	a.	p.
Main reservoir dam with waste weir and sluices	Rs.	9,52,121	14	9
Kirkee open duct	,,	78,458	6	4
,, settling and expense reservoirs	,,	16,642	3	1
,, main pipe	,,	1,06,831	8	4
,, distribution pipes to Powder Works	,,	56,277	0	0
Poona open duct	,,	1,22,000	2	2
,, settling and expense reservoirs	,,	23,887	8	0
,, pipe to Ghorepooree Lines	,,	10,673	4	0
Total	Rs.	13,66,891	14	8

31. The distribution of the water afterwards throughout the Bazar, Civil Lines, and environs of Poona might be carried out with the aid of Bazar and Municipal Funds, and a cess on houses, which owners would be quite willing enough to pay, for property beyond Municipal limits.

32. The cost of supplying the troops and Government Departments with water, according to a statement received from the Quarter Master General of the Army and other data obtained from the Public Works Department (see Appendix C), is Rs. 36,130 per annum, taking the average of the three past years. This average,

however, is not a fair criterion, because the increasing expense during the latter years is in a great measure owing to the rise in the rate of hire for bullocks, &c. To guide us, therefore, with respect to future expenses, supposing delay should occur in constructing water works, it would be more correct to take the expense of the last year shown in the statement. This expense may be divided under two heads; the cost of supply which comprises the expense of pumping the water from the Jamsetjee Bund, and its maintenance; and the cost of conveying the water by bullocks and carts from the river or wells and the central reservoir near the Poona Arsenal to the troops and Departments. Dividing the expense in this manner we find that the cost of supply is Rs. 11,750, and of distribution Rs. 29,544.

33. It is not easy to say what the cost to private individuals is for bheestees, but from what I have learnt from the Bazar Master at Poona of the number of bheestees in the Cantonment, I feel sure I am understating the expense when I set it down at Rs. 60,000 per annum.

34. Much of the annual cost of distribution is caused from the great distance the bheestees have at present to carry the water, and the time they lose in drawing it from deep wells, where they have not only the labour of hauling the water up, but are also kept waiting by the crowds of people who congregate to obtain their daily supply of the precious fluid. Government is no doubt aware that it is only by placing guards over the wells that the Brigade authorities can manage the distribution of the small quantity of water obtainable.

35. If the water works now under consideration be carried out without the most perfect distributing apparatus, the expense of distribution by the ordinary means will still be greatly reduced. There would be no occasion to have recourse to the river at Kirkee. Water would be obtainable within a few yards of the Barracks and Horse Lines. At Poona the facilities would be similarly increased. Bheestees, instead of having to wander about from well to well, and carry the water a mile to its destination, would obtain it at the central reservoir at St. Mary's Church, at a point near the Arsenal, where the pipe to Ghorepooree will pass, and within a few

yards of the Ghorepooree Barracks. The expense of distribution will certainly be reduced to one-fourth of what it costs just now. Government would thus be saved :—

1st.	The cost of supplying water..... Rs.	11,750
2nd.	Three-fourths of cost of present distribution (*Rs. 29,544*) ..... „	22,158
	Total.... Rs.	33,908
	The public would be saved three-fourths of Rs. 60,000, or ..... Rs.	45,000
	Total.... Rs.	78,908

36. In conclusion, it is only necessary for me to add a few words of explanation respecting the amalgamation of this water supply project, with the large irrigation project which I am now preparing agreeably to Government Resolution No. $\frac{536\ CW}{1504}$ dated 13th July 1865. The irrigation project will require a much larger reservoir, and the lake dam will have to be raised 34 feet higher than that provided for in the estimate now submitted. If Government should contemplate carrying out the irrigation project at an early date, it would be very advantageous to at once make the foundations of the masonry dam of a thickness suitable for that project, though for the present the dam itself need not of course be made higher than is required for the Poona and Kirkee water supply plan. The additional thickness of foundation will add Rs. 1,09,368 to the cost, but the arrangement will effect a clear saving of the whole cost of the smaller dam for the Poona and Kirkee water supply. The dam for the irrigation project will answer for all purposes, the quantity of water that will be withdrawn for Poona and Kirkee ($7\frac{1}{4}$ cubic feet per second) being really so small compared to that which will be furnished for irrigation (450 feet per second), as to be almost inappreciable in its effect on the cost of the large dam for the irrigation project.

37. With respect to distributing arrangements the carrying out of the irrigation project will not necessitate any change whatever on the Kirkee side of the river, the duct on that side being already

in the minor project its full size. On the Poona side a large canal will take the place of the small duct, but the line will be precisely the same, and the reservoirs and all details of distribution will remain unaltered. If Government should carry out the irrigation project, the duct to Poona may be gradually enlarged, and nearly all the work which will be executed for the minor project will answer as part of the larger one.

38. Or to summarize: If the large irrigation project is carried out, the cost of the water supply of Poona will, practically speaking, be really confined to three miles of open duct near Kirkee (the remainder being necessary for irrigation), the distribution works at Kirkee and Poona, with the settling and expense reservoirs at both places. In figures the cost will stand as follows:—

		Rs.	a.	p.
Three miles of open duct near Kirkee at Rs. 4,805 per mile	Rs.	14,415	0	0
Settling and expense reservoirs	,,	16,642	3	1
Main pipe at Kirkee	,,	1,06,831	8	4
Distribution pipes to Powder Works	,,	56,277	0	0
Distribution pipes to Cantonment	,,	24,795	0	0
Settling and expense reservoirs at Poona Cantonment	,,	23,887	8	0
Main pipe	,,	32,358	14	4
Distribution pipes	,,	79,129	13	8
Cost of raising water for Wanowree Lines	,,	94,600	0	0
Total	Rs.	4,48,936	15	5

39. Should the project now submitted be approved, I would strongly urge an immediate commencement of the dam at Kurrukwasla, that the foundations may be got in, and the work raised about 20 feet before the monsoon floods commence, otherwise a whole year will be lost, as it is only between the present time of the year and April that impounding works can be commenced. If commenced early the dam could be brought up to a height of 20 feet during the present season. During the following season it could be brought up to the level of the site of the waste weir, the foundation of the waste weir only being put in to give the water a free escape at a low level. By February 1868, or in two years and three

months from the present time, the works could completed to their full height, and as the reservoir would be filled by the monsoon of 1867, and the stream which continues to flow after the monsoon is past, the water supply works, except for irrigation, could be in full operation from December 1867, or even earlier, as the surface of the reservoir would be above the feeding level of the ducts. As another reason for recommending the immediate commencement of the works, I should mention that my assistant, Lieutenant Buckle, R.E., who has been engaged on the project during the past year, and who is fully acquainted with all my views and the whole of the details of the plans, is now on the spot, and Government is well aware of the great advantage of employing an officer to carry out a large work who has been engaged on the preparation of the plans.

I have the honour to be, Sir,

Your most obedient Servant,

J. G. FIFE, Lieutenant-Colonel,
Superintending Engineer for Irrigation.

ESTIMATES

FOR

POONA AND KIRKEE WATER SUPPLY PROJECT.

ESTIMATE framed by Lieutenant Colonel FIFE, *Superintending Engineer for Irrigation, of the Probable Expense of constructing Water Works for the supply of the Cantonments of Poona and Kirkee, the New Powder Works and Arsenal, and Poona City, with its environs. Estimate framed agreeably to Government Resolution No.* $\frac{536 \text{ C.W.}}{1504 \text{ of } 1865}$, *dated 13th July, and Government Resolution No.* $\frac{213 \text{ M.W.}}{1733 \text{ of } 1865}$, *dated 10th August* 1865.

GENERAL DESCRIPTION.

The works are to consist of a dam across the river Moota to form a reservoir, two open ducts to lead the water thence to settling and expense reservoirs at Poona and Kirkee; and iron pipes to distribute the water throughout the Cantonments and Powder Works, as also a horse-power engine to raise the water for a small portion of the Poona Cantonment, viz. the Wanowree Barracks. The general description of the arrangements is given in a more complete manner in the transmitting report on the Works.

DETAILED DESCRIPTION OF DAM, WASTE WEIR, AND WING WALL.

The dam, waste weir, and wing wall will be founded on rock throughout the whole length.

The dam, which is to be of masonry, is to have a section in which the base = ·55 of the height, measured up to the highest water line; the thickness at top = $\frac{1}{4}$th of the base. Batter on water face = $\frac{1}{20}$th of height. Batter in rear to be $\frac{4}{11}$ths of height.

The dam to be raised 3 feet above highest water line, or 8 feet above the crest of waste weir, and to be surmounted by a parapet wall 2 feet thick and 3 feet high. This section will give a top thickness to the dam of 10·56 feet where it is highest in the centre of the valley. Where the height of the dam is much less, and where the proportion given would reduce the total thickness to less than 4 feet, the section to be modified by omitting the batters first on the water face, and then on the rear face, that the top thickness may never be less than 4 feet.

The dam will thus become rectangular in section where it is very low, and the mass of masonry will be unnecessarily heavy, but this cannot be avoided, as 4 feet must be regarded as a minimum for the top thickness.

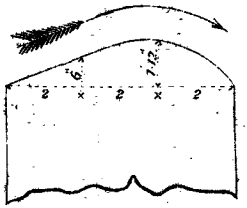
At the south end of the dam, four small sluice openings to be constructed, with valves working vertically against the water face. The sluice openings to be 3 feet wide and 3 feet high, and arched over. At the north end of the waste weir 3 similar sluices to be constructed to supply the Kirkee duct. The sills of the sluices to correspond in level with the bottoms of the ducts. The sluices to be worked from above by rack and pinion action. When the water is escaping over the waste weir the sluices in the waste weir may be closed, as the duct will then receive its supply from the waste water. To prevent the waste water flooding the Kirkee duct, a stop gate to be constructed where the duct enters a cutting after getting clear of the waste weir channel.

The wing wall where the dam terminates and where the waste weir begins, to have precisely the same section as the dam itself, that is, in proportion to the head of water it has to sustain, but with minimum top thickness of 3 feet.

The dam and wing wall, though founded on rock, might still not prevent leakage through the rock, supposing any cavities to exist in the rock, and to prevent this, and staunch the water as completely as possible, good puddling earth to be added to both sides of the dam to one-third its height, *vide* sections of dam. The slope of the earthen banks to be one in two, horizontal, where the dam crosses the river bed; all the gravel overlying the rock to be carefully removed before the puddling earth is laid down.

The wing wall to have a similar bank of earth, but on its rear side only.

The waste weir to have a stronger section than the dam, as it will be exposed to more severe action. Its thickness to be equal to one-half the height; to be perpendicular on the down stream face, and with a batter of one-sixth of the height on the up stream face. Where these proportions would reduce the top thickness at the low end to less than 4 feet, the batter to be omitted, and the section made rectangular, that the top thickness may not be less than 4 feet. The top to be slightly rounded. *See* diagram.



SPECIFICATION OF DAM, WASTE WEIR, AND WING WALL.

The unwatering of the foundations at the deep part of the dam will be best effected by forming a small cut about 10 feet wide through the gravel from the dam site to the nearest pool, which is at a distance of about 500 feet, and forming a similar cut at the lower end of the pool at a distance of one mile from the site. The water level may thus be lowered till the rock, on which the dam is to be built, is laid dry.

The whole of the masonry at the dam, wing wall, and waste weir, to be of common coursed rubble, with the exception of the water faces of the dam, wing wall, and waste weir, which are to be of closer jointed work. The joints, however, are not to be fine in the dam, otherwise there will be unequal settlement in the face and body of the work. Half-inch joints will be quite close enough, and the stones should be only hammer-dressed. The wing wall water face should be the same as the dam to within 50 feet of where it joins the waste weir, where the face work should be the same as that of the waste weir. The waste weir down stream face and coping to be quarter-inch close jointed work, the joints being one quarter of an inch only. The coping to be made of stones not less

than 1½ feet by nine inches; the top to be roughly chisel dressed; the stones on the down stream face of the waste weir, though close jointed, need not have their faces dressed off with the chisel.

The sluice openings to be of the best close quarter-inch jointed work, and the stones dressed smooth on the face, that the stream may not be impeded; the stones used for the grooves to be not less than 2 feet × 1 foot 9 inches. The valve or shutter to be of teakwood. The parapet wall on the dam to be of ordinary coursed rubble masonry, with rounded coping, close jointed, but surface unchiselled; the top of the dam to be roughly hammer dressed.

The lime used for all the work to be hydraulic. Nearly all the Deccan lime is naturally hydraulic, but that used for these important works must be carefully tested, to prevent ordinary lime being used. The stone to be of durable quality, and quarried close to the works. Very large stones, just as they come from the quarry, may be used for the body of the dam, waste weir, and wing wall, but the greatest care must be taken to fill in all interstices between them with smaller stones, chips, and mortar. As far as the shape of the stones is concerned, the very coarsest work will suffice, provided all the interstices are carefully filled in, so as to make the work really solid and water-tight.

In procuring puddling earth for the slopes on both sides of the dam, no excavations are to be formed anywhere in rear of the dam, and not within 200 feet of it in front. The material must be taken at a distance exceeding 200 feet in front of, and immediately below, the waste weir.

The Ducts.

The ducts will be generally entirely excavated, as they are too small in section to admit of half cutting and half embanking to answer. The excavated material will be nearly all required to shut out local surface drainage from the fields on both sides, but principally on the high side.

The sections of the ducts to be as follows:—

Kirkee Duct.—Fall one foot per mile; bottom width 5 feet; depth $2\frac{1}{2}$ feet. The slopes 1 in $1\frac{1}{2}$; theoretical velocity and discharge 1·4745 feet per second, and 32·2775 cubic feet per second.

Poona Duct.—Fall per mile 6 inches; bottom width 10 feet; depth 3 feet; side slopes 1 in $1\frac{1}{2}$; theoretical velocity and discharge 1·2023 and 52·30 cubic feet per second respectively. All drainage is to be passed underneath the ducts by means of aqueducts, culverts, and syphon culverts; and all aqueducts standing on a rock formation to have their parapet walls made lower in the centre than at the wings, that they may serve as escapes should too much water ever get into the ducts. At the head of the Poona duct a retaining wall to be carried along the lower side of the duct, rising to 3 feet above water level, as far as Kurrukwasla, to prevent injury to the head-works, supposing any thing should get out of order with the sluices, and more water enter the duct than it could carry off. Beyond Kurrukwasla the surplus water would find a ready and safe escape back to the river again by means of the nullah on which No. 1 aqueduct will be constructed. Retaining wall to have a bank of earth against it, and to have a thickness one-fourth of height, and to be founded on rock or hard moorum. At the head of the Kirkee duct, the lower side of the duct, where it will cross the waste weir channel, for a short distance to be retained by a masonry wall, having a thickness = one-half its height, but the minimum thickness to be not less than 2 feet; and where it is attached to the waste weir, and for a distance of 60 feet, its top thickness to be not less than 4 feet, as it will be subjected to a very severe action here from the waste weir overfall.

Specification for Aqueducts, Culverts, and Road Bridges.

Foundations and superstructure to be of uncoursed masonry, of the commonest coursed rubble, with all interstices between carefully filled with chips and good mortar, that the wall may be solid and water tight. Copings to parapets to be of dressed stone. All aqueducts standing on a hard foundation to have the parapets lower in the centre (equal to full supply level of duct) than at wings, that they may act as escapes.

The four Poona Road Bridges, for the Sunkersett Road, near cemetery, the cross road at north west angle, Commissariat enclosure, the main road near Mr. Faulconer's auction rooms, and the Sholapoor Road, Bazar, to have the superstructure and parapets of good coursed rubble, and coping of close jointed work, to be in keeping with other road bridges about Poona. On the Kirkee duct the road bridge for the old Bombay Road is to have masonry of the same character. The backs of aqueduct arches to be covered with six inches of concrete, with surface well finished off, to prevent leakage.

V.—Miscellaneous Public Improvements.

Poona and Kirkee Water Supply.

ESTIMATE No. 2 of 1865-66.

SHEET No. 1.

ESTIMATE framed by Lieutenant Colonel FIFE, *Superintending Engineer for Irrigation, of the Probable Cost of constructing a Bund across the valley of the river Moota, near Kurrukwasla, to form a Storage Lake. Estimate framed agreeably to the instructions contained in Government Resolutions No.* $\frac{536 \text{ C.W.}}{1504 \text{ of } 1865}$, *dated 13th July* 1865, *and* $\frac{213 \text{ M.W.}}{1773 \text{ of } 1865}$, *dated 10th August* 1865.

Amount of Estimate, Rupees 7,52,710-2-4.

GENERAL DESCRIPTION.

The total length of the bund, including waste weir, is 4,596 feet. For the various dimensions of dam, waste weir, wing-wall, earthen embankment, parapet wall, &c., *see* General Description, pages 17, 18, 19.

CONSTRUCTION.

For the details of construction *see* Specification, pages 19, 20.

MEASUREMENTS.

Excavation for foundation in earth.	Number.	Length.	Breadth.	Depth.	SOLID FEET.
From 0 to Section No. 1	1	42	10	2	840·00
From No. 1 to No. 2.....	1	24	11·31	2·5	678·60
From No. 2 to No. 3.....	1	12	11·87	2	284·88
From No. 3 to No. 4.....	1	28	10·85	2	607·60
From No. 8 to No. 9.....	1	118	29·66	8·5	29,748·98
Carried over....	..	..	..	..	

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Excavation for foundation in earth—continued.					
Brought forward....	..	..	..	..	
From Sect. No. 9 to Sect. No. 10..	1	14	31·47	12·75	56,173·95
From No. 10 to No. 11.....	1	143	33·46	15·25	72,967·89
From No. 11 to No. 12.....	1	20	36·7	19	13,946·00
From No. 12 to No. 13	1	216	39·16	19	160,712·64
From No. 13 to No. 14	1	13	40·8	19	1,007·76
From No. 14 to No. 15.....	1	11	41	19	8,169·00
From No. 15 to No. 16.....	1	223	41·57	19	176,132·09
From No. 16 to No. 17.....	1	13	43·91	16·5	9,418·70
From No. 17 to No. 18	1	91	47·90	8	34,871·20
From No. 20 to No. 21.....	1	254	49·18	4·5	56,212·74
From No. 21 to No. 22.....	1	15	45·62	7·5	5,132·25
From No. 22 to No. 23.....	1	23	43·35	10	9,970·50
From No. 23 to No. 24.....	1	84	41·27	11	38,133·48
From No. 24 to No. 25.....	1	19	38·15	13·50	9,785·47
From No. 25 to No. 26.....	1	90	36·81	12·50	41,411·25
From No. 26 to No. 27.....	1	72	38·10	6·00	16,459·20
From No. 27 to No. 28.....	1	17	37·76	4	2,567·68
From No. 28 to No. 29.....	1	133	33·39	5·5	24,424·78
From No. 29 to No. 30.....	1	218	30·40	2·5	16,568·00
From No. 30 to No. 31.....	1	80	29·66	1·25	2,966·00
From No. 31 to No. 32.....	1	239	26·82	2 12	13,589·54
From No. 32 to No. 33.....	1	13	23·69	3·12	960·86
From No. 33 to No. 34.....	1	174	18·10	3·25	10,235·55
Total solid feet excavation in earth.....					813,976·59

Excavation for foundation in rock.					
From Section No. 4 to No. 5	1	23	10·41	1	291·48
From No. 5 to No. 6.....	1	91	14·52	1·5	1,981·98
From No. 6 to No. 7.....	1	235	19 97	2	938·59
From No. 7 to No. 8.....	1	28	25·51	2·5	1,785·70
From No. 18 to No. 19.....	1	134	51·62	3	20,751·24
From No. 19 to No. 20.....	1	26	51·74	5	6,726·20
Carried forward....	..	....	....	....	

Excavation for foundation in rock—continued.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Brought forward....	..	..	..	..	
From Section No. 20 to Sec. No. 21	1	254	49·18	3	37,475·16
From No. 21 to No. 22.....	1	15	45·62	3	2,052·90
From No. 22 to No. 23..	1	23	43·35	3	2,991·15
From No. 23 to No. 24.....	1	84	41·27	3	10,400·04
From No. 24 to No. 25.....	1	19	38·15	3	2,174·55
From No. 25 to No. 26..... ..	1	90	36·81	3	9,938·70
From No. 26 to No. 27.....	1	72	38·1	3	8,229·60
From No. 27 to No. 28.....	1	17	37·76	3	1,925·76
From No. 28 to No. 29.....	1	133	33·39	3	13,325·61
From No. 29 to No. 30.....	1	218	30·4	3	19,881 60
From No. 30 to No. 31.....	1	80	29·66	3	7,120·90
From No. 31 to No. 32.....	1	239	26·82	2·5	16,024·95
From No. 32 to No. 33.....	1	13	23·69	2	615·94
From No. 33 to No. 34.....	1	174	20·1	2	6,994·80
Total solid feet excavation in rock.....					171,625·95
Filling in foundation with rubble stone and lime.					
From 0 to Section No. 1, 1st step..	1	42	8	1	336·00
Do. do. 2nd do. ..	1	42	6	2	504·00
From No. 1 to No. 2, 1st step. ..	1	24	11·31	1	271·44
Do. do. 2nd do.	1	24	8·81	1·5	317·16
From No. 2 to No. 3, 1st step.....	1	12	11·87	1	142·44
Do. do. 2nd do.	1	12	9·87	1	118·44
From No. 3 to No. 4, 1st step....	1	28	10·85	1	303·80
Do. do. 2nd do.	1	28	8·85	0·5	123·90
From No. 4 to No. 5, 1st step.....	1	28	10·41	1	291·48
From No. 5 to No. 6, 1st step.....	1	91	14·52	1	1,321·32
Do. do. 2nd do.....	1	91	12·52	0·5	569·66
From No. 6 to No. 7, 1st step. ..	1	235	19·97	1	4,692·95
Do. do. 2nd do.	1	235	17·97	1	4,222·95
From No. 7 to No. 8	1	28	23·01	2·5	1,610·70
From No. 8 to No. 9, 1st step	1	118	26·16	3·5	10,804·08
Do. do. 2nd do.....	1	118	24·47	5	14,437·30
Carried over....	..	..	..	..	

Filling in of foundation with rubble stone and lime—continued.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Brought forward..	..	..	..	..	
From No. 9 to No. 10, 1st step ..	1	14	27·97	3·5	1,370·53
Do. do. 2nd „ ..	1	14	24·47	9·25	3,168·86
From No. 10 to No. 11, 1st step ..	1	143	29·97	3·5	14,999·98
Do. do. 2nd „ ..	1	143	26·48	1·75	44,493·02
From No. 11 to No. 12, 1st step ..	1	20	32·7	4	2,616·00
Do. do. 2nd „ ..	1	20	28·7	15	8,610·00
From No. 12 to No. 13, 1st step ..	1	216	35·16	4	30,378·24
Do. do. 2nd „ ..	1	216	31·16	5	100,958·40
From No. 13 to No. 14, 1st step ..	1	13	36·84	4	1,915·68
Do. do. 2nd „ ..	1	13	32·88	5	6,411·60
From No. 14 to No. 15, 1st step ..	1	11	37	4	1,628·00
Do. do. 2nd „ ..	1	11	33	15	5,445·00
From No. 15 to No. 16, 1st step ..	1	223	37·57	4	33,512·44
Do. do. 2nd „ ..	1	223	33·67	15	112,291·65
From No. 16 to No. 17, 1st step ..	1	13	39·91	4	2,075 32
Do. do. 2nd „ ..	1	13	35·91	12·5	5,835·37
From No. 17 to No. 18, 1st step ..	1	91	44·4	3·5	14,141 40
Do. do. 2nd „ ..	1	91	40·9	5	18,609·50
From No. 18 to No. 19	1	134	48·32	3	19,545·24
From No. 19 to No. 20, 1st step ..	1	26	48·73	3	3,800·94
Do. do. 2nd „ ..	1	26	45·74	2	2,378·48
From No. 20 to No. 21, 1st step ..	1	254	46·13	3	35,151·06
Do. do. 2nd „ ..	1	254	43·13	4·5	49,297·59
From No. 21 to No. 22, 1st step ..	1	15	42·62	3	1,917·90
Do. do. 2nd „ ..	1	15	39·62	7·5	4,457·25
From No. 22 to No. 23, 1st step ..	1	23	40·35	3	2,784·15
Do. do. 2nd „ ..	1	23	37·35	10	8,590·50
From No. 23 to No. 24, 1st step ..	1	84	38·27	3	9,644·04
Do. do. 2nd „ ..	1	84	35·27	11	32,589·48
From No. 24 to No. 25, 1st step ..	1	19	35·15	3	2,003·55
Do. do. 2nd „ ..	1	19	32·15	13·5	8,273·47
From No. 25 to No. 26, 1st step ..	1	90	33·81	3	9,144·90
Do. do. 2nd „ ..	1	90	30·81	12·5	34,661·25
From No. 26 to No. 27, 1st step ..	1	72	35·1	3	7,581·60
Do. do. 2nd „ ..	1	72	32·1	6	13,867·20
From No. 27 to No. 28, 1st step ..	1	17	34·76	3	1,772·76
Do. do. 2nd „ ..	1	17	31·76	4	2,159·68
From No. 28 to No. 29, 1st step ..	1	133	30·39	3	12,125·61
Do. do. 2nd „ ..	1	133	27·39	6	21,857·2 2
Carried over....	..	..	..	..	

Filling in of foundation with rubble stone and lime—continued.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Brought forward....	..	..	..	..	
From No. 29 to No. 30, 1st step ..	1	218	27·4	3	17,919·06
Do. do. 2nd „ ..	1	218	24·4	3	15,957·60
From No. 30 to No. 31, 1st step ..	1	80	26·66	3	6,398·40
Do. do. 2nd „ ..	1	80	23·66	1·25	2,366·00
From No. 31 to No. 32, 1st step ..	1	239	24·32	2·5	14,531·20
Do. do. 2nd „ ..	1	239	21·82	2·12	11,055·75
From No. 32 to No. 33, 1st step ..	1	13	21·69	2	563·94
Do. do. 2nd „ ..	1	13	19·62	3·12	795·78
From No. 33 to No. 34, 1st step ..	1	174	20·1	2	6,994 80
Do. do. 2nd „ ..	1	174	18·1	3 25	10,235·55
Total solid feet filling in of rubble stone and chunam....					818,950·56

Superstructure, of coursed rubble masonry.	Number.	Length.	Area.	Solid Feet.
From 0 to Section No. 1	1	42	16·00	672·00
From No. 1 to No. 2	1	24	39·70	552·80
From No. 2 to No. 3	1	12	68·10	817·20
From No. 3 to No. 4	1	28	84·00	2,352·00
From No. 4 to No. 5	1	28	94·66	2,650·48
From No. 5 to No. 6	1	91	165·55	15,065·05
From No. 6 to No. 7	1	235	328·99	77,212·65
From No. 7 to No. 8	1	28	498·26	13,950·88
From No. 8 to No. 9	1	118	615·69	72,415·42
From No. 9 to No. 10	1	14	712·43	9,974·02
From No. 10 to No. 11	1	143	816·55	116,766·65
From No. 11 to No. 12	1	20	957·41	19,148·20
From No. 12 to No. 13	1	216	1,122·13	242,380·08
From No. 13 to No. 14	1	13	1,247·15	16,212·95
From No. 14 to No. 15	1	11	1,260·73	13,868·03
From No. 15 to No. 16	1	228	1,305·67	291,164·41
From No. 16 to No. 17	1	13	1,493·34	19,413·42
From No. 17 to No. 18	1	91	1,944·8	176,976·80
From No. 18 to No. 19	1	134	2,401·58	221,811·72
From No. 19 to No. 20	1	26	2,413·95	62,762·70
Carried forward....	..	....	.....	

Superstructure, of coursed rubble masonry—continued.	Number.	Length.	Area.	Solid Feet.
Brought forward..	..	..	....	
From No. 20 to No. 21	1	254	2,148·71	545,772·34
From No. 21 to No. 22	1	15	1,815·72	27,235·80
From No. 22 to No. 23	1	23	1,611·23	37,058·29
From No. 23 to No. 24	1	84	1,442·10	121,161·60
From No. 24 to No. 25	1	19	1,199·65	22,793·35
From No. 25 to No. 26	1	90	1,100·13	99,011·70
From No. 26 to No. 27	1	72	1,195·28	86,060·16
From No. 27 to No. 28	1	17	1,171·64	19,917·88
From No. 28 to No. 29	1	133	880·83	117,150·39
From No. 29 to No. 30	1	218	693·66	151,217·85
From No. 30 to No. 31	1	80	658·00	52,240·00
From No. 31 to No. 32	1	239	559·00	133,601·00
From No. 32 to No. 33	1	13	460·52	5,986·76
From No. 33 to No. 34	1	174	897·46	69,158·04
Parapet wall	1	2,938	6·	17,628·00
Total solid feet superstructure of coursed rubble and chunam.				2,882,160·65

Facing, of rock ashlar.	Number.	Length.	Depth.	Superficial Feet.
From 0 to Section No. 1	1	42	7	294·00
From No. 1 to No. 2.....	1	24	12·7	304·80
From No. 2 to No. 3.....	1	12	16·67	200·04
From No. 3 to No. 4.....	1	28	18·46	516·88
From No. 4 to No. 5.....	1	28	19·48	545·44
From No. 5 to No. 6.....	1	91	25·14	2,287·74
From No. 6 to No. 7.....	1	235	35·04	8,234·40
From No. 7 to No. 8.....	1	28	40·80	1,142·40
From No. 8 to No. 9	1	118	44·76	5,281·68
From No. 9 to No. 10.....	1	14	50·5	707·00
From No. 10 to No. 11.....	1	143	54·16	7,744·88
From No. 11 to No. 12.....	1	20	58·18	1,163·60
From No. 12 to No. 13.....	1	216	62·66	13,534·56
From No. 13 to No. 14.....	1	13	65·79	855·27
Carried over.....	..	..	..	

Facing, of rock ashlar— continued.	Number.	Length.	Depth.	Superficial Feet.
Brought over.....	..	....	....	
From No. 14 to No. 15.....	1	11	66·	726·00
From No. 15 to No. 16.....	1	223	67·05	14,952·15
From No. 16 to No. 17.....	1	13	71·30	926·90
From No. 17 to No. 18.....	1	91	78·87	7,177·17
From No. 18 to No. 19.....	1	134	88·96	11,920·64
From No. 19 to No. 20.....	1	26	89·17	2,318·42
From No. 20 to No. 21.....	1	254	84·44	21,447·76
From No. 21 to No. 22.....	1	15	78·05	1,170·75
From No. 22 to No. 23.....	1	23	73·92	1,700·16
From No. 23 to No. 24.....	1	84	70·14	5,891·76
From No. 24 to No. 25.....	1	19	64·46	1,224·74
From No. 25 to No. 26.....	1	90	62·02	5,581·80
From No. 26 to No. 27.....	1	72	64·37	4,634·64
From No. 27 to No. 28.....	1	17	63·75	1,083·75
From No. 28 to No. 29.....	1	133	55·82	7,424·06
From No. 29 to No. 30.....	1	218	50·38	10,982·84
From No. 30 to No. 31.....	1	80	49·03	3,922·40
From No. 31 to No. 32.....	1	239	45·68	10,917·52
From No. 32 to No. 33.....	1	13	41·81	543·53
From No. 33 to No. 34.....	1	174	37·41	6,509·34
Total superficial feet rock ashlar masonry....				163,869·02

Earth work. *Embankment on each side of the dam.*	Number.	Length.	Area.	Solid Feet.
From 0 to Section No. 1	1	42	7·11	298·62
From No. 1 to No. 2.....	1	24	21·36	512·64
From No. 2 to No. 3.....	1	12	40·80	489·60
From No. 3 to No. 4.....	1	28	49·50	1,386·00
From No. 4 to No. 5.....	1	28	54·63	1,529·64
From No. 5 to No. 6.....	1	91	101·15	9,204·65
From No. 6 to No. 7.....	1	235	209·46	49,223·10
From No. 7 to No. 8.....	1	28	322·00	9,016·00
Carried over.....	..	..	..	

Earth work.	Number.	Length.	Area.	Solid Feet.
Embankment on each side of the dam—continued.				
Brought forward.....	..	..	....	
From No. 8 to No. 9.....	1	118	388·12	45,798·16
From No. 9 to No. 10.....	1	14	443·37	6,207·18
From No. 10 to No. 11.....	1	143	515·73	73,749·39
From No. 11 to No. 12.....	1	20	608·51	12,170·20
From No. 12 to No. 13.....	1	216	709·52	153,256·32
From No. 13 to No. 14.....	1	13	791·70	10,292·10
From No. 14 to No. 15.....	1	11	719·59	7,915·49
From No. 15 to No. 16.....	1	223	736·14	164,159·22
From No. 16 to No. 17.....	1	13	949·17	12,339·21
From No. 17 to No. 18.....	1	91	1,202·64	109,440·24
From No. 18 to No. 19.....	1	134	1,434·22	192,185·48
From No. 19 to No. 20.....	1	26	1 443·74	37,587·24
From No. 20 to No. 21.....	1	254	1,302·96	330,951·84
From No. 21 to No. 22.....	1	15	1,138·11	17,071·65
From No. 22 to No. 23.....	1	23	995·87	22,905·01
From No. 23 to No. 24.....	1	84	901·43	75,720·12
From No. 24 to No. 25.....	1	19	764·01	14,516·19
From No. 25 to No. 26.....	1	90	693·46	62,411·40
From No. 26 to No. 27.....	1	72	745·14	53,650·08
From No. 27 to No. 28.....	1	17	735·55	12,504·35
From No. 28 to No. 29.....	1	133	546·15	72,637·95
From No. 29 to No. 30.....	1	218	430·18	93,779·24
From No. 30 to No. 31.....	1	80	425·30	34,064·00
From No. 31 to No. 32.....	1	239	366·04	87,483·56
From No. 32 to No. 33.....	1	13	299·46	3,892·98
From No. 33 to No. 34.....	1	174	254·98	44,366·52
Total solid feet embankment.....				1,822,665·37
Deduct excavation in earth				813,976·59
Total solid feet earth work				1,008,868·78

REGULATING SLUICES.

General Description.

The regulating sluices to be of teakwood, four in number for the Poona (right bank) duct, and three in number for the Kirkee (left bank) duct. They are to be worked in grooves from the top of the wall in each case, by means of a crab. Their sills to be flush with the bottom of the duct.

Construction.

The shutters to be 3 feet high by 3 feet wide, and arched over, the rise of the arch being 6 inches, and they are to be 3 inches in thickness. The grooves to be 3 inches deep, of 2nd sort cutstone. The shutters to be connected with the crabs by wooden rods, 3 inches square, to within 4 feet of the top of the wall, above that by the windlass chain. Both the foundations and superstructure of the walls between the sluices to be of coursed rubble in chunam. The arch ring of 2nd sort cutstone.

Sluices on the Kirkee or Left Bank.

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Coursed rubble masonry and chunam.					
Foundation	1	18	10·5	1	189·00
Superstructure	3	3	10·5	4·5	425·25
Total solid feet coursed rubble masonry					614·25
Arch-work.			Area.		
Archrings	3	10·5	8·15		276·72
Total solid feet arch-work					276·72

Grooves.

	Number.	Length.	Running Feet.
Grooves	3	16	48
Total running feet grooves			48

Wood-work.

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Teak rods	3	13·5	0·25	0·25	2·53
		area			
Do. planks	3	14·26		0·25	10·69
Total solid feet wood-work					13·22

Iron-work.

	Number.	Length.	Running Feet.
Chain	3	8	24
Total running feet chain			24

	Number.	Length.	Total.
Crabs, double purchase	1	..	1
Do. single, light	1	..	1
Total crabs			2

Sluices on the Poona or Right Bank.

Coursed rubble masonry and chunam.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Foundation	1	27	21	1	567·00
Superstructure	1	15	21	4·5	1,417·50
Bedding of retaining wall	1	27	21	1	567·00
Superstructure of retaining	2	26	2	1	108·00
Total solid feet coursed rubble masonry					2,659·50

Arch-work.			Area.	
Archrings	4	21	8·15	684·60
Total solid feet archwork				684·60

Grooves.	Number.	Length.	Running Feet.
Grooves	4	16	64
Total running feet grooves			64

Wood-work.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Teak rods	4	16	0·25	0·25	4·00
Do. planks	4	Area. 14·26		0·25	14·26
Total solid feet wood-work.....					18·26

Iron-work.	Number.	Length.	Running Feet.
Chain	4	8	32
Total running feet chain.....			32

Crabs, double purchase, complete, ...No. 2.

Centering.	Number.	Length.	Area.	Solid Feet.
For the left bank sluices	3	10·5	11·01	346·81
For the right bank sluices...	4	21	11·01	924·84
Total solid feet centering.....				1,271·65

Coursed rubble masonry. *Deduct on account of sluices:—*	Number.	Length.	Breadth.	Depth.	Solid Feet.
For the left bank sluices	1	23·5	5·5	10·5	1,357·12
For the right bank sluices	1	27	6·5	10	1,755·00
Total deduction for sluices.....					3,112·12

ABSTRACT.

Quantities.	Items.	Amount.		
		Rs.	a.	p.
813,976 59	Cubic feet excavation for foundation in earth, at 8 annas per 100 cubic feet	4,069	14	1
171,625·95	Cubic feet excavation in rock, at Rs. 4 per 100 cubic feet	6,865	0	5
818,950·56	Cubic feet filling in foundation with uncoursed rubble masonry and chunam, at Rs. 16 per 100 cubic feet.....	1,31,032	1	5
2,879,048 53	Cubic feet superstructure of coursed rubble masonry, at Rs. 18 per 100 cubic feet....	5,18,228	11	9
163,869·02	Superficial feet facing, of rock ashlar masonry, at Rs. 28 per 100 superficial feet.....	45,883	5	2
1,008,688·78	Cubic feet of embanking, at 8 annas per 100 cubic feet	5,043	7	1
3,273·75	Cubic feet coursed rubble masonry for sluices, at Rs. 20 per 100 cubic feet.....	654	12	0
961·32	Cubic feet archwork, at Rs. 40 per 100 cubic feet	384	8	5
112	Running feet second sort cutstone, for grooves, at Rs. 2 per foot run	224	0	0
31·50	Cubic feet teakwood for sluice gates, at Rs. 6 per cubic foot.....	189	0	0
3	Crabs, double purchase, at Rs. 170 each....	510	0	0
1	Crab, single, at Rs. 90 each	90	0	0
40	Running feet chain at Rs. 1½ per foot.....	60	0	0
1,271·65	Cubic feet centering, at Rs. 16 per 100 cubic feet	203	7	5
	Total amount for dam	7,13,438	3	9
	Add 5 per cent. for contingencies	35,671	14	7
	Add for extra Establishment:—			
4	Carcoons for two years:—			
	1 at Rs. 20 per mensem	480	0	0
	2 at Rs. 15 per „	720	0	0
	1 at Rs. 12 per „	288	0	0
8	Muccadums at Rs. 10 per mensem	1,920	0	0
1	Chowkeydar at Rs. 8 per mensem	192	0	0
	Grand Total ....Rupees	7,52,710	2	4

(Signed) J. G. FIFE, Lieutenant Colonel, R.E.,
Superintending Engineer for Irrigation.

V.— Miscellaneous Public Improvements.

Poona and Kirkee Water Supply.

ESTIMATE No. 2 of 1865-66.

ESTIMATE framed by Lieutenant Colonel J. G. Fife, *Superintending Engineer for Irrigation, of the Probable Cost of constructing the Waste Weir in connection with the Dam across the river Moota, at Kurrukwasla. Estimate framed agreeably with instructions contained in Government Resolutions Nos.* $\frac{536\ C\ W}{1504\ of\ 1865}$, *dated 13th July* 1865, *and* $\frac{213\ M\ W}{1733\ of\ 1865}$, *dated 10th August* 1865.

Amount of Estimate, Rs. 74,886-11-1.

General Description.

A full description of this portion of the work will be found in the report and specification.

Construction.

The details of construction are fully given in the specification; and for calculations to prove the capability of carrying off the necessary quantity of water, *vide* Appendix B, attached.

Measurements.

Excavation for foundation in rock.	Number.	Length.	Area.	Solid Feet.
From Sec. No. 34 to Sec. No. 35.....	1	160	40·6	6,496·00
From No. 35 to No. 36	1	355	34·48	12,240·40
From No. 36 to No. 37	1	213	28·12	5,989·56
From No. 37 to No. 38	1	295	23·12	6,820·40
From No. 38 to No. 39	1	366	18·92	6,924·72
From No. 39 to No. 40	1	108	17·42	1,881·36
From No. 40 to No. 0	1	240	16·00	3,840 00
Total solid feet excavation in rock....				44,192·44

Filling in foundation, of uncoursed rubble masonry and chunam.	Number.	Length.	Area.	Solid Feet.
From Sec. No. 34 to Sec. No. 35.....	1	160	20·302	3,248·32
Ditto ditto	1	160	18·302	2,928·32
From No. 35 to No. 36.....	1	355	17·24	6,120·20
Ditto ditto	1	355	15·24	5,410·20
From No. 36 to No. 37.....	1	213	14·062	2,995·20
Ditto ditto	1	213	12·062	2,569·20
From No. 37 to No. 38.....	1	295	11·562	3,410·79
Ditto ditto	1	295	9·562	2,820·79
From No. 38 to No. 39.....	1	366	9·462	3,463·09
Ditto ditto	1	366	7·462	2,731·09
From No. 39 to No. 40.....	1	108	8·71	940·68
Ditto ditto	1	108	6·71	724·68
From No. 40 to No. 0	1	240	8·00	1,920·00
Ditto ditto	1	240	6·00	1,440·00
Total solid feet filling in foundation				40,722·56

Superstructure, of coursed rubble masonry and chunam.				
From Sec. No. 34 to Sec. No. 35.	1	160	403·308	64,529·28
From No. 35 to No. 36.....	1	355	278·616	98,908·68
From No. 36 to No. 37.....	1	213	152·268	32,433·08
From No. 37 to No. 38.....	1	295	91·381	26,957·39
From No. 38 to No. 39.....	1	366	42·440	15,533·04
From No. 39 to No. 40.....	1	108	33·065	3,571·02
From No. 40 to No. 0	1	240	25·	6,000·00
Total solid feet superstructure.....				247,932·49

Facing, of rock ashlar masonry.	Number.	Length.	Depth.	Superficial Feet.
From Sec. No. 34 to Sec. No. 35	1	160	68·53	10,964·80
From No. 35 to No. 36	1	355	55·85	19,826·75
From No. 36 to No. 37	1	213	42·68	9,090·84
From No. 37 to No. 38	1	295	31·93	9,419·35
From No. 38 to No. 39	1	366	22·52	8,242·32
From No. 39 to No. 40	1	108	19·27	2,081·16
From No. 40 to No. 0	1	240	16·50	3,960·00
Total superficial feet rock ashlar masonry.....				63,585·22

ABSTRACT.

Quantities.	Items.	Amount. Rs.	a.	p.
44,192·44	Solid feet excavation in rock, at Rs. 4 per 100 cubic feet	1,767	11	1
40,722·56	Cubic feet filling in foundation, of uncoursed rubble masonry, at Rs. 16 per 100 cubic feet.	6,515	9	7
247,932·49	Cubic feet superstructure of coursed rubble masonry, at Rs. 18 per 100 cubic feet	44,627	13	5
63,585·22	Superficial feet facing of rock ashlar masonry, at Rs. 28 per 100 superficial feet	17,803	13	0
	Total.....	70,714	15	1
	Add 5 per cent. for contingencies	3,535	12	0
	Extra Establishment:—			
1	Carcoon for 12 months at Rs. 15 per mensem..	180	0	0
3	Muccadums at Rs. 10 per mensem	360	0	0
1	Chowkeydar at Rs. 8 per mensem.....	96	0	0
	Grand Total.....Rs.	74,886	11	1

(Signed) J. G. FIFE, Lieutenant Colonel, R.E.,
Superintending Engineer for Irrigation.

V.—Miscellaneous Public Improvements.

Poona and Kirkee Water Supply.

ESTIMATE No. 2 of 1865-66.

ESTIMATE framed by Lieutenant Colonel Fife, *Superintending Engineer for Irrigation, of the Probable Cost of constructing a Wing Wall in connection with the Dam at Kurrukwasla. Estimate drawn up agreeably to instructions contained in Government Resolutions, Nos.* $\frac{536 \text{ CW}}{1504 \text{ of } 1865}$, *dated 13th July* 1865, *and* $\frac{213 \text{ MW}}{1733 \text{ of } 1865}$, *of 10th August* 1865.

Amount of Estimate, Rs. 46,725-1-4.

General Description.

The wing wall to be built at an angle of 30 degrees with the general line of the dam, and to commence at the point of junction of the dam and waste weir. Its total length is 1,023 feet. For further description *vide* Specification.

Construction.

The wing wall to be of coursed rubble masonry, with an earthen embankment on the reverse face, extending up to one-third of the height of the wall, and having a slope of one-half. Its height where it leaves the dam to be the same as that of the dam, and to be 10 feet in height at the foot. For details of construction *see* Specification.

Measurements.

Excavation for foundation in earth.	Number.	Length.	Breadth.	Depth.	Solid Feet.
1st portion	1	223	20·26	0·5	2,258·99
2nd portion	1	80	18·00	1·5	2,160·00
3rd portion	1	8	17·76	2	284·16
4th portion	1	57	16·81	1	958·17
Carried forward....	..	....	....	....	

Excavation for foundation in earth—continued.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Brought over....	..	..	..	..	
5th portion	1	15	16·15	0·5	121·12
6th portion	1	253	14·88	1·5	5,646·96
7th portion	1	194	12·31	3	7,164·42
8th portion	1	27	11·06	3	895·86
9th portion	1	88	10·25	3	2,706·00
10th portion	1	78	9·51	3	2,225·34
Total solid feet of excavation in earth					24,421·02
Excavation in rock.					
1st portion	1	223	20·26	2	9,035·96
2nd portion	1	80	18 00	2	2,880·00
3rd portion	1	8	17·76	2	284·16
4th portion	1	57	16·81	2	1,916·34
5th portion	1	15	16·15	2	484·50
6th portion	1	253	14·88	2	7,529·28
7th portion	1	194	12·31	2	4,776·28
8th portion	1	27	11·06	2	597·24
9th portion	1	88	10·25	2	1,804·00
10th portion	1	78	9·51	2	1,483·56
Total solid feet of excavation in rock....					30,791·32
Filling in foundation with uncoursed masonry.					
1st portion	1	223	19·26	2	8,539·96
2nd portion	1	80	17·00	2	2,720·00
3rd portion	1	8	16·76	2	268·16
4th portion	1	57	15·81	2	1,802·34
5th portion	1	15	15·15	2	454·50
6th portion	1	253	13·88	2	7,023·28
7th portion	1	194	11·31	2	4,388·28
8th portion	1	27	10·06	2	543·24
9th portion	1	88	9·25	2	1,628·00
10th portion	1	78	8·51	2	1,327·56
Total solid feet of foundation of uncoursed masonry....					28,745·32

	Number.	Length.	Areas calculated by the Prismoidal formula.	Solid Feet.
Superstructure, of coursed rubble masonry.				
1st portion	1	223	A = 397·85 4B = 1,265·92 C = 244·50	70,922·92
2nd portion	1	80	A = 244·50 4B = 968·00 C = 239·50	19,360·00
3rd portion	1	8	A = 239·50 4B = 939·90 C = 230·49	1,879·84
4th portion	1	57	A = 230·49 4B = 881·08 C = 186·37	11,858·43
5th portion	1	15	A = 186·37 4B = 760·02 C = 193·67	2,850·15
6th portion	1	253	A = 193·67 4B = 632·92 C = 126·29	40,178·93
7th portion	1	194	A = 126·29 4B = 410·09 C = 81·12	19,964·54
8th portion	1	27	A = 81·12 4B = 318·70 C = 78·40	2,151·90
9th portion	1	88	A = 78·40 4B = 265·37 C = 55·55	5,856·40
10th portion	1	78	A = 55·55 4B = 221·34 C = 55·25	4,317·30
Total solid feet of superstructure of coursed rubble masonry.				179,340·41

Embankment.	Number.	Length.	Area.	Solid Feet.
1st portion	1	223	A = 100·00 4B = 350·84 C = 76·32	19,592·78
2nd portion	1	80	A = 76·32 4B = 212·00 C = 34·15	4,299·20
3rd portion	1	8	A = 34·15 4B = 178·64 C = 56·65	359·20
4th portion	1	57	A = 56·65 4B = 199·56 C = 43·68	2,848·86
5th portion	1	15	A = 43·68 4B = 266·24 C = 60·13	777·50
6th portion	1	253	A = 60·13 4B = 126·08 C = 12·15	8,447·67
7th portion	1	194	A = 12·15 4B = 31·68 C = 4·66	1,567·52
8th portion	1	27	A = 4·66 4B = 18·16 C = 4·44	122·58
9th portion	1	88	A = 4·44 4B = 11·70 C = 1·68	261·36
10th portion	1	78	A = 1·68 4B = 6·03 C = 1·33	117·00
			Total solid feet of embankment....	38,393·67
			Deduct the quantity of excavation for foundation in earth	24,421·02
			Total solid feet of embankment	13,972·65

	Number.	Length.	Area.	Solid Feet.
Superficial feet facing.				
Facing, superficial feet in rock ashlar masonry	1	50	397·85	19,892·50
Total superficial feet of facing				19,892·50

ABSTRACT.

Quantities.	Items.	Amount. Rs.	a.	p.
38,393·67	Solid feet excavation in earth, at 8 annas per 100 solid feet.....	191	15	5
30,791·32	Solid feet excavation in rock at Rupees 4, per 100 solid feet.....	1,231	10	4
28,745·32	Solid feet of filling in foundation with uncoursed masonry, at Rupees 16 per 100 solid feet ..	4,599	4	0
179,340·41	Solid feet of superstructure of coursed rubble masonry, at Rupees 18 per 100 solid feet....	32,281	4	4
13,972·65	Solid feet of earth embankment, at 8 annas per 100 solid feet	69	13	9
19,892·50	Superficial feet of facing, second sort cutstone, at Rupees 28 per 100 superficial feet	5,569	14	5
	Total ....Rupees	43,943	14	3
	Add 5 per cent for contingencies	2,197	3	1
	Add for extra establishment :—			
1	Carcoon for 8 months, at Rupees 20 per month.	160	0	0
1	Carcoon for 8 months, at Rupees 15 per month.	120	0	0
3	Mookadums for 8 months, at Rupees 10 per month	240	0	0
1	Chowkedar for 8 months, at Rupees 8 per month.....	64	0	0
	Grand Total of Rupees for constructing a wing-wall.....	46,725	1	4

(Signed) J. G. FIFE, Lieut. Colonel, R.E.,
Superintending Engineer for Irrigation.

V.—Miscellaneous Public Improvements.

Poona and Kirkee Water Supply.

ESTIMATE No. 2 of 1865-66.

ESTIMATE framed by Lieutenant Colonel Fife, *Superintending Engineer for Irrigation, of the Probable Cost of constructing Settling and Expense Reservoirs, in connection with the Duct on the Left Bank of the river Moota, at Gunesh Khind. Estimate framed agreeably to instructions contained in Government Resolutions Nos.* $\frac{536\ CW}{1504\ of\ 1865,}$ *dated 13th July* 1865, *and* $\frac{213\ MW}{1733\ of\ 1865,}$ *of August* 1865.

Amount of Estimate, Rs. 16,642-3-1.

General Description.

The tanks to be formed on the slope of the hill near Gunesh Khind. They are to be enclosed by a wall, backed by an earthen embankment on the low side, and divided from each other by a partition wall, furnished with a sluice gate. The main pipe for the supply of water to Kirkee passes out through the boundary wall of the expense reservoir. Each reservoir will contain sufficient water for four days' consumption.

Construction.

The exterior wall to be of coursed rubble masonry and chunam, and to have a mean thickness equal to one-fourth of the height. The earthen embankment on the reverse face to have a thickness equal to the height of the wall, in addition to a rear slope of one-half. The length of the exterior wall is 1,474 feet. The partition wall to be of similar material, and to have a mean thickness equal to half the height, and to be 610 feet long. It is provided with a sluice gate at the lower end, one foot square, worked from above by a light crab, similar to those to be used for the main sluice gates of the dam.

MEASUREMENTS.

Excavation for foundation of the exterior wall, in hard moorum.	Number.	Length.	Breadth.	Depth.	SOLID FEET.
1st portion	1	23	3·5	1·5	120·75
2nd portion	1	33	3·5	2·5	285·75
3rd portion	1	33	3·5	2·5	285·75
4th portion	1	33	3·5	2·50	285·75
5th portion	1	33	3·5	2·5	285·75
6th portion	1	33	3·5	2·5	285·75
7th portion	1	33	4	2·50	330·00
8th portion	1	33	4·5	2·50	371·25
9th portion	1	33	5·00	2·50	412·50
10th portion	1	90·5	6·50	2·50	1,470·67
11th portion	1	52·5	7·00	2·50	918·75
12th portion	1	9·0	7·50	3·00	202·50
13th portion	1	15·00	8·50	3·25	414·37
14th portion	1	113·00	7·00	3·00	2,373·00
15th portion	1	23·00	8·50	3·50	634·25
16th portion	1	73·00	7·50	3·00	1,642·50
17th portion	1	70·00	7·50	3·00	1,575·00
18th portion	1	104·00	6·50	2·75	1,859·00
19th portion	1	70	5·00	2·50	875·00
20th portion	1	70	4·50	2·50	787·50
21st portion	1	70	4·00	2·50	700·00
22nd portion	1	70	4·00	2·50	700·00
23rd portion	1	70	4·00	2·50	700·00
24th portion	1	70	3·50	2·50	612·50
25th portion	1	19	3·50	2·00	133·00
Waste weir.					
1st portion	1	51	4·50	2·50	573·75
2nd portion	1	72	3·75	2·00	540·00
3rd portion	1	58	3·50	2·50	507·50
4th portion	1	18	3·50	2·50	157·50
Wing wall.					
1st portion	1	4·35	5·15	2	44·80
2nd portion	1	10·44	4·25	2	88·75
Partition wall.					
1st portion	1	8·5	13·5	3·5	401·62
2nd portion	1	46	11·8	2·5	1,357·00
3rd portion	1	46	11·1	2·5	1,276·50
4th portion	1	46	10·4	2·5	1,196·00
Carried forward	..	....	....	....	-

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Partition wall—continued.					
Brought over....	..	....	....	....	
5th portion	1	46	9·7	2·5	1,115·50
6th portion	1	46	9·00	2·5	1,035·00
7th portion	1	46	8·3	2·5	954·50
8th portion	1	46	7·6	2·5	874·00
9th portion	1	46	6·9	2·5	793·50
10th portion	1	46	6·2	2·5	713·00
11th portion	1	46	5·5	2·5	632·50
12th portion	1	46	4·8	2·5	552·00
13th portion	1	65	4·1	2·75	732·87
14th portion	1	19	4	2	152·00
Total solid feet of excavation for foundation in moorum..					32,010·08
Filling in foundation with uncoursed rubble masonry.					
1st to 7th portion	1	188	3	1	564·00
7th portion	1	33	3·50	1	115·50
8th portion	1	33	4·00	1	132·00
9th portion	1	33	4·50	1	148·50
10th portion	1	90·5	5·50	1·50	497·75
11th portion	1	52·5	6·00	1·50	472·50
12th portion	1	9·0	6·50	1·50	85·75
13th portion	1	15·00	7·50	1·50	168·75
14th portion	1	113·00	6·50	1·50	1,101·75
15th portion	1	23·00	7·50	1·50	258·75
16th portion	1	73	6·50	1·50	711·75
17th portion	1	70	6·00	1·50	630·00
18th portion	1	104	5·50	1·50	858·00
19th portion	1	70	4·50	1·00	315·00
20th portion	1	70	4·00	1·00	280·00
21st to 24th portion	1	210	3·50	1·00	735·00
24th to 25th portion	1	89	3·00	1·00	267·00
Waste weir.					
1st portion	1	51	4	1	204·00
2nd portion	1	72	3·25	1	234·00
3rd and 4th portions	1	76	3·00	1	228·00
Carried forward	..	....	....	....	

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Brought over....	..	..	..	..	
Wing wall.					
1st portion	1	4·35	4·50	1	19·57
2nd portion	1	10·44	3·75	1	39·15
Partition wall.					
1st portion	1	9·25	12·5	1·5	173·43
2nd portion	1	46	11·3	1	519 80
3rd portion	1	46	10·6	1	487·60
4th portion	1	46	9·9	1	455·40
5th portion	1	46	9·2	1	423·20
6th portion	1	46	8·5	1	391·00
7th portion	1	46	7·8	1	358·80
8th portion	1	46	7·1	1	326·60
9th portion	1	46	6·4	1	294·40
10th portion	1	46	5·7	1	262·20
11th portion	1	46	5·0	1	230·00
12th portion	1	46	4·3	1	197·80
13th portion	1	65	3·6	1	234·00
14th portion	1	19	3·5	1	66·50
Total solid feet of filling in foundation with uncoursed rubble masonry.....					12,489·45
Superstructure.					
1st portion	1	22	1·5	1	33·00
2nd portion	1	33	1·5	3	148·50
3rd portion	1	33	1·5	4	198·00
4th portion	1	33	1·5	5	247·50
5th portion	1	33	1·5	6	297·00
6th portion	1	33	2	7	462·00
7th portion	1	33	2	8	528·00
8th portion	1	33	2·23	9	668·25
9th portion	1	33	2·50	10	825·00
10th portion	1	90·5	2·75	11	2,735·62
11th portion	1	52·5	3·00	12·33	1,942·50
12th portion	1	9·00	3·25	13·66	399·75
13th portion	1	15·00	3·75	15·00	843·75
14th portion	1	113	3·25	13·50	4,957·87
Carried forward	..	..	..	..	

Superstructure—continued.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Brought forward..	..	..	....	....	
15th portion	1	23	3·75	15·00	1,293·75
16th portion	1	73	3·25	13·50	3,202·87
17th portion	1	70	3.00	12·50	2,625·00
18th portion	1	104	2·75	11·50	3,289·00
19th portion	1	70	2·50	10·50	1,837·50
20th portion	1	70	2·25	9·50	1,496·25
21st portion	1	70	2·00	8·50	1,190·00
22nd portion	1	70	2·00	7·50	1,050·00
23rd portion	1	70	1·50	6·50	682·50
24th portion	1	70	1·50	5·50	577·50
25th portion	1	19	1·50	4·50	128·25
Waste weir.					
1st portion	1	51	2·00	3·50	357·00
2nd portion	1	72	1·62	2·50	262·39
3rd portion	1	58	1·50	2·00	174·00
4t h ortion	1	18	1·50	1·00	27·00
Wing wall.					
1st portion	1	4·35	2·37	4·50	46·39
2nd portion	1	9·44	1·75	3·25	53·69
Partition wall.					
1st portion	1	10	7·5	15	1,125·00
2nd portion	1	46	7·0	14	4,508·00
3rd portion	1	46	6·5	13	3,887 00
4th portion	1	46	6·00	12	3,312 00
5th portion	1	46	5·5	11	2,783·00
6th portion	1	46	5·00	10	2,300·00
7th portion	1	46	4·50	9	1,863·00
8th portion	1	46	4·00	8	1,472·00
9th portion	1	46	3·50	7	1,127·00
10th portion	1	46	3·10	6	855·60
11th portion	1	46	2·75	5	632·50
12th portion	1	46	2·40	4	441·60
13th portion	1	65	2·50	3	487·50
14th portion	1	19	2·00	1	38·00
Total solid feet of superstructure, of coursed rubble masonry ..					57,412·03

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Deduct :—					
			Area.		
For main pipe, 15 inches diameter..	1	4·50	1·23		5·53
For sluice opening	1	9·00	1·00		9·00
For groove itself.....	1	13·00	0·50		6·5
Total solid feet of deduction....					21·03
Earthen embankment.					
1st portion	1	22	1	0·50	11·00
2nd portion	1	33	3	1·50	148·50
3rd portion	1	33	5	2·50	412·50
4th portion	1	33	7	3·50	808·50
5th portion	1	33	9	4·50	1,336·50
6th portion	1	33	11	5·50	1,996·50
7th portion	1	33	13	6·50	2,788·50
8th portion	1	33	14·79	7·50	3,660·50
9th portion	1	33	16·57	8·50	4,647·38
10th portion	1	90·50	19 32	10·00	17,484·60
11th portion	1	52·50	21·75	11·33	12,937·44
12th portion	1	9·00	23·21	12·16	2,540·10
13th portion	1	15	24·95	13·25	4,958·31
14th portion	1	113	22 89	12	31,038·84
15th portion	1	23	24·33	13	7,274·67
16th portion	1	73	22·89	12	20,051·64
17th portion	1	70	21·12	11	16,262·40
18th portion	1	104	19·83	10·25	21,138·78
19th portion	1	70	17·57	9·00	11,069·10
20th portion	1	70	15·79	8·30	8,242·40
21st portion	1	70	14·00	7·00	6,860·00
22nd portion	1	70	12·00	6·00	5,040·00
23rd portion	1	70	10·00	5·00	3,500·00
24th portion	1	70	10·00	5·00	3,500·00
25th portion	1	17·50	6·00	3·00	315·00
Total solid feet of earthen embankment.....					186,764·16
Deduct :—					
Excavation of the exterior wall and partition wall	..	....	....	....	11,785·99 20,224·09
			Area.		
Do. for pipe, 15 inches diameter..	1	39	1·23		48·00
Total solid feet of deduction.....					20,272·09

Wood work.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Teak, plank	1	3	1	0·25	0·75
Teak, rod	1	12	0·25	0·25	0·75
Total solid feet of well seasoned teak-wood					1·50

Cutstone work.	Number.	Length.	Running Feet.
Groove	1	11·5	11·5
Total running feet of cutstone work			11·5

Iron work.	No.	Length.	Total.
Light crab, single purchase	1	....	No. 1
Chain	1	6	Rn. Ft. 6
Valve	1	....	No. 1

ABSTRACT.

QUANTITIES.	ITEMS.	AMOUNT. Rs.	a.	p.
32,010·08	Solid feet excavation for foundation in moorum, at Rs. 1 per 100 solid feet	320	1	7
12,489·45	Solid feet filling in foundation with uncoursed rubble masonry, at Rupees 16 per 100 solid feet.	1,998	5	0
57,391·00	Solid feet superstructure of coursed rubble masonry, at Rs. 20 per 100 solid feet	11,478	3	2
154,706·08	Solid feet earthen embankment, at 8 annas per 100 solid feet	773	8	5
1·5	Solid feet of well seasoned teak wood, at Rupees 6 per solid foot.....	9	0	0
11·5	Running feet of cut stone work for groove at Rupees 2 per foot run.....	23	0	0
1	Crab, single purchase.....	90	0	0
6	Running feet chain, at Rupees 1½ per foot run..	9	0	0
	Valve	200	0	0
	Total.. Rs..	14,901	2	2
	Add 5 per cent for contingencies	745	0	11
	Add for extra Establishment:—			
1	Carcoon for 1 year at the rate of Rupees 20 per month	240	0	0
1	Carcoon for 1 year at the rate of Rupees 15 per month	180	0	0
4	Moocadums at the rate of Rupees 10 each, for 1 year.....	480	0	0
1	Chowkeedar for 1 year at 8 Rupees per month.	96	0	0
Grand Total Rupees for constructing settling and expense reservoirs at Gunesh Khind		16,642	3	1

(Signed) J. G. FIFE, Lieut. Colonel, R.E.,
Superintending Engineer for Irrigation.

V.—Miscellaneous Public Improvements.

Poona and Kirkee Water Supply.

ESTIMATE No. 2 of 1865-66.

ESTIMATE framed by Lieut. Colonel Fife, *Superintending Engineer for Irrigation, of the Probable Cost of excavating a Duct on the Left Bank of the river Moota for the supply of Water at Kirkee. Estimate framed agreeably to Government Resolutions Nos.* $\frac{536\ CW}{1504\ of\ 1865}$, *dated 13th July* 1865, *and* $\frac{213\ MW}{1733\ of\ 1865}$, *of 10th August* 1865.

Amount of Estimate Rs. 31,390-13-3.

General Description.

The duct to be 5 feet wide at bottom, with side slopes of 1 to $1\frac{1}{2}$, and $2\frac{1}{2}$ feet deep. These dimensions are maintained throughout, there being no tapering towards the tail, as explained in the Report. The fall throughout is 1 foot per mile. Length of duct 16 miles 17 chains 34 feet.

Construction.

The embankments to be made in layers of one foot in thickness, and well rammed and watered. For the construction of the screen wall, which extends as far as the 1st aqueduct, *vide* Specification. The stop gate at the 1st aqueduct to be a double one, the gates abutting on a centre post. It is to be of teakwood, 3 inches thick, and secured by a wooden bar and iron staple.

Excavation in earth.	Number.	Length.	Breadth.	Depth.	Solid Feet.
1st mile, 1st portion	1	1,380	6·20	1·75	14,973·00
2nd portion	1	534	8·75	2·50	11,681·25
3rd portion	1	299	8·75	2·50	6,540·62
2nd mile, 1st portion	1	697	8·75	2·50	15,246·87
2nd mile, 1st portion	1	354	8·00	2·00	5,664·00
2nd portion	1	1,793	8·00	2 00	28,688·00
3rd portion	1	2,681	8·75	2·50	58,646 87
3rd mile, 1st portion	1	1,657	8·75	2·50	36,246·87
2nd portion	1	1,535	8·75	2·50	33,578·12
3rd portion	1	50	8·75	1·25	546·87
4th portion	1	343	8·75	1·25	3,751·56
5th portion	1	1,294	8·75	2 50	28,306·25
4th mile, 1st portion	1	1,438	8·75	2·50	31,456·25
2nd portion	1	1,138	8·75	2·50	24,893·75
3rd portion	1	80	8·75	1 25	875·00
4th portion	1	100	8·75	1·25	1,093·75
5th portion	1	136	8·75	2·50	2,975·00
5th mile, 1st portion	1	896	8·75	2·50	19,600·00
2nd portion	1	2,139	6·00	0·70	8,983·80
3rd portion	1	80	8·75	1·25	875·00
4th portion	1	99	8·75	1·25	1,082·81
5th portion	1	403	8·75	2·50	8,815·62
6th mile, 1st portion	1	30	8·75	1·25	328·12
2nd portion	1	176	8·75	2·50	3,850·00
3rd portion	1	3,148	7·5	1·70	40,137·00
8th mile, 1st portion	1	914	8·75	2·50	19,993·75
2nd portion	1	1,303	8·75	2·50	28,503·12
3rd portion	1	50	8·75	1·25	546·87
4th portion	1	465	8·75	2·50	10,171·87
9th mile, 1st portion	1	220	8·75	1·25	2,406·25
2nd portion	1	903	8·75	2·50	19,753·12
3rd portion	1	40	8·75	1·25	437·50
4th portion	1	189	11·75	4·50	9,993·37
5th portion	1	50	8·75	2·50	1,093·75
10th mile, 1st portion	1	1,557	8·75	2·50	34,059·37
2nd portion	1	1,162	9·50	3·00	33,117·00
3rd portion	1	1,278	9·875	3·25	40,855·34
11th mile, 1st portion	1	214	9·95	3·30	7,026·69
2nd portion	1	59	14·375	6·25	5,300·78
3rd portion	1	505	10·625	3·75	20,121·09
4th portion	1	700	11·75	4·50	37,012·50
5th portion	1	1,165	16·25	7·50	141,984·37
12th mile, 1st portion	1	1,181	16·25	7·50	143,934·37
2nd portion	1	196	9·5	3·00	5,556·00
Carried over....	..	....	....	....	

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Excavation in earth—continued.					
Brought forward....	..	....	....	....	
12th mile, 3rd portion	1	587	8·75	2·50	12,840·62
4th portion	1	375	9·50	3·00	10,687·50
5th portion	1	939	8·75	2·50	20,540·62
13th mile, 1st portion	1	1,964	8·75	2·50	42,962·50
2nd portion	1	100	8·75	1·25	1,093·75
3rd portion	1	237	8·75	1·25	3,139·06
4th portion	1	2,081	8·75	2·50	45,521·87
5th portion	1	203	8·75	1·25	2,220·31
14th mile, 1st portion	1	1,882	10·625	3·75	74,985·93
15th mile, 1st portion	1	782	8·75	2·50	17,106·25
2nd portion	1	100	8·75	1·25	1,093·75
3rd portion	1	1,326	8·75	2·50	29,006·25
4th portion	1	842	8·75	2·50	18,418·75
16th mile, 1st portion	1	629	8·75	2·50	13,759·37
2nd portion	1	1,450	12·125	4·75	83,510·93
3rd portion	1	3,485	10·25	3·50	125,024·37
Total solid feet excavation in earth					1,452,615·32

Excavation in moorum.					
6th mile, 1st portion	1	1,267	5·75	0·5	3,642·62
7th mile, 1st portion	1	4,971	5·375	0·25	6,679·78
8th mile, 1st portion	1	1,070	8·75	2·50	2,340·62
2nd portion	1	619	6·875	1·25	5,319·53
3rd portion	1	621	7·00	1·00	4,347·00
9th mile, 1st portion	1	19	6·35	0·9	108·58
2nd portion	1	326	5·75	0·5	937·25
10th mile, 1st portion	1	903	6·80	1·20	7,368·48
2nd portion	1	560	6·875	1·25	4,812·50
12th mile, 1st portion	1	931	7·25	1·50	10,668·37
15th mile, 1st portion	1	2,071	5·75	0·50	5,954·12
16th mile, 1st portion	1	1,469	8·75	2·50	32,134·37
Total solid feet excavation in moorum.....					84,313·22

Embanking.	Number.	Length.	Breadth.	Depth.	Solid Feet.
1st mile, 1st portion	2	1,380	10·22	0·75	21,155·40
2nd „	1	100	26·00	1·75	4,550·00
„ „	2	100	10·50	5·00	10,500·00
3rd „	1	225	26·25	1·75	11,714·06
„ „	2	225	10·50	5·00	267,750·00
4th „	2	385	10·5	2·50	20,212·50
5th „	2	124	10·50	2·50	6,510·00
6th „	2	605	10·50	5·00	63 525·00
„ „	1	258	28·25	1·75	12,754·87
„ „	1	93	32·00	3·00	8,928·00
„ „	1	264	28·25	1·75	13,051·50
7th „	2	779	10·50	5·00	81,795·00
2nd mile, 1st „	2	354	10·25	0·50	3,628·50
2nd „	1	111	44·00	2·00	9,768·00
„ „	2	111	9·75	2·25	4,870·12
3rd „	2	1,793	10·25	0·50	18,378·25
4th „	1	120	46·25	2·75	15,262·50
„ „	2	120	9·75	2·25	5,265·00
5th „	1	43	45·5	2 50	4,891·25
„ „	2	43	9·75	2·25	1,886·62
3rd mile, 1st „	1	100	46·25	2·75	12,718·75
„ „	2	100	9·75	2 25	4,387·50
2nd „	1	49	47·00	3 00	6,909·00
„ „	2	49	9·75	2·25	2,149·87
3rd „	2	50	6·00	2 00	1,200·00
4th „	1	50	41·00	1·25	2,562·50
„ „	2	50	9·75	2·25	2,193·75
5th „	2	343	6·00	2·00	8,232·00
4th mile, 1st „	2	2,196	9·75	4·50	192,699·00
2nd „	1	50	42·50	1·50	3,187·50
„ „	2	50	8·75	2·25	2,193·75
3rd „	1	42	41·00	1·00	1,722·00
„ „	2	42	9·75	2·25	1,842·75
5th mile, 1st „	1	2,139	40·70	1·80	156,703·14
„ „	2	2,139	6·00	2·00	51,336·00
2nd „	1	85	42·5	1·50	5,418·75
„ „	2	85	9·75	2·25	3,729·37
3rd „	1	100	42·5	1·50	6,375·00
„ „	2	100	9·75	2·25	4,387·50
4th „	1	40	41·00	1·00	1,640·00
„ „	2	40	9·75	1·00	780·00
6th mile, 1st „	1	70	46	2·00	6,440·00
„ „	2	70	9·75	2·00	2,730·00
2nd „	2	3,148	7·60	0·80	38,279·68
3rd „	2	235	10·00	4·70	22,090·00
4th „	2	1,267	9·00	4·00	91,424·00
Carried forward....	..	....	....	....	

		Number.	Length.	Breadth.	Depth.	Solid Feet.
	Brought over.....	..	...	....	....	
7th mile,	1st portion	2	4,971	9·375	4 25	396,126 62
8th mile,	1st „	2	619	10·625	1·25	16,442·18
	2nd „	1	70	42·50	1·50	4,462·50
	„ „	2	70	9·75	2·25	30,712·50
	3rd „	2	691	8·40	3·60	35,862·75
9th mile,	1st „	2	19	8·40	3·60	1,149·12
	2nd „	1	50	42·50	1·50	3,187·50
	„ „	2	50	9·75	4·50	4,387·50
	3rd „	1	50	44·0	2·00	4,400·00
	„ „	2	50	9·75	4·50	4,387·50
	4th „	2	326	9·00	4·00	23,472·00
	5th „	1	80	43·25	1·75	6,055·00
	„ „	2	80	9·75	4·50	7,020·00
	6th „	1	770	40·625	1·75	54,742·18
	„ „	2	770	9·75	4·50	67,567·50
	7th „	2	341	9·75	4·50	29,922·75
	8th „	1	948	38·30	0·20	7,261·68
	„ „	2	948	9·75	4·50	83,187·00
	9th „	2	943	9·75	4·50	82,748·25
	10th „	2	220	12·75	1·25	7,012·50
	11th „	2	40	12·75	1·25	1,275·00
	12th „	1	56	41·75	1·25	2,922·50
	„ „	2	56	9·75	4·5	4,914·00
10th mile,	1st „	2	903	11·00	1·30	25,825·25
	2nd „	1	207	40·00	1·00	8,280·00
	„ „	2	207	9·75	4·50	18,164·25
	3rd „	2	560	11·625	1·75	22,785·00
11th mile,	1st „	1	2,551	40·00	1·00	102,040·00
	„ „	2	2,551	9·75	4·50	223,850·25
12th mile,	1st „	2	981	8·00	1·00	15,696·00
	2nd „	2	890	9·75	4·50	78,097·50
13th mile,	1st „	2	100	9·75	2·25	4,387·50
	2nd „	1	100	1·75	1·25	5,218·75
	„ „	2	100	9·75	4·50	8,775·00
	3rd „	1	90	0·00	0·5	1,800·00
	„ „	2	90	9·75	4 50	7,897·50
	4th „	2	287	9·75	2·25	12,592·12
	5th „	2	203	9·75	2·25	8,906·62
	6th „	2	229	9·75	4·50	20,094·75
14th mile,	1st „	2	3,398	9·75	4·50	298,174·50
15th mile,	1st „	2	100	9·75	2·25	4,387·50
	2nd „	1	51	40·25	1·50	3,079·12
	„ „	2	51	9·75	4·50	4,475·25
	3rd „	2	2,071	9·00	4·00	149,112·00
	Total solid feet embanking					3,122,585·77

Retaining Wall.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Excavation for foundation in earth.					
1st portion	1	50	6	1	300·00
2nd „	1	880	5·5	1	4,840·00
Total solid feet excavation....					5,140·00
Filling in foundation with uncoursed rubble stone and chunam.					
1st portion	1	50	6	1·00	300·00
2nd „	1	880	5·50	1·00	4,840·00
Total solid feet filling in with stone and chunam....					5,140·00
Superstructure, of coursed rubble masonry.					
1st portion	1	50	4	5·50	1,100·00
2nd „	1	880	2·75	5·50	13,310·00
Total solid feet superstructure					14,410·00
Masonry on account of stop gate.					
Door	2	2	3·75	1	15·00
Total solid feet masonry					15·00

Stop Gate. *Woodwork.*		Feet.	Inches.	Inches.	
Teakwood posts	3	7	4·5	4·5	3·00
Do. planks	1	8·50	3	5 ft.	10·63
Do. bar	1	5·00	2	3	0·21
Total cubic feet of teakwood					13·84

Iron work.	Number.	Weight of each.	Total Weight.
		lbs.	lbs.
Hinges	4	1½	6
Staples	2	1	2
Straps	4	1	4
2 inch screws, 1 dozen, and 1 pivot.			
		Total lbs. ironwork....	12

ABSTRACT.

Quantities.	Items.	Amount.
		Rs. a. p.
84,313·22	Solid feet excavation in moorum, at Rs. 1 per 100 cubic feet.....	843 2 1
1,452,615·32	Solid feet excavation in earth, at 8 annas per 100 solid feet.....	7,263 1 2
3,122,585·77	Solid feet embanking, at 8 annas per 100 solid feet.	15,612 14 10
5,140	Solid feet excavation for foundation in earth, at 8 annas per 100 solid feet	25 11 2
5,140	Solid feet filling in foundation with stone and chunam, at Rs. 16 per 100 solid feet	822 6 5
14,425	Solid feet superstructure, of coursed rubble, at Rs. 20 per 100 solid feet	2,885 0 0
13·84	Solid feet teakwood, well seasoned, at Rs. 6 per foot	83 0 7
	Screws and pivot	0 8 0
12	lbs. iron, at 8 annas per pound	6 0 0
	Total....Rs.	27,541 12 3
	Add 5 per cent. for contingencies	1,377 1 5
	Add for extra Establishment:—	
3	Carcoons for 1 year, at Rs. 20, 15, 12, respectively.	564 0 0
8	Muccadums at Rs. 10 per month, for 1 year.....	960 0 0
8	Chowkeydars at Rs. 8 per do. do.	768 0 0
1	Store-keeper at Rs. 15 per do. do.	180 0 0
	Grand Total for left bank duct .....Rs.	31,390 13 8

(Signed) J. G. FIFE, Lieut. Colonel, R.E.,
Superintending Engineer for Irrigation.

MAIN PIPE.

General Description.

The iron pipe will leave the bottom of the expense reservoir 10 feet below the high water level, and will be provided with a stop valve outside of the retaining wall of the reservoir, that, in case of any accident occurring to the main pipe between the reservoir and Kirkee cantonment and Powder Works, the water may be at once shut off. The main pipe from the reservoir to the Kirkee cantonment is to be 14 inches in diameter, and is to follow the general undulations of the ground. From the cantonment of Kirkee to the delivery point near the Powder Works, the diameter of the pipe will be reduced to 12 inches, in proportion to the expenditure of water. The main pipe will be provided with stop, scouring, and air valves, as indicated on the plan.

Measurements.

Excavating a Trench for laying pipes.	Number.	Length.	Breadth.	Depth.	Solid Feet.
From the expense reservoir at Gunesh Khind to the Kirkee Cantonment	1	6,692	2	4	53,536
From the Kirkee Cantonment to the Powder Works factories....	1	5,960	2	4	47,680
Total solid feet excavation in moorum, &c. ...					101,216
Filling in Trench.					
From the expense reservoir at Gunesh Khind to the Kirkee Cantonment	1	6,692	2	4	53,536
From the Kirkee Cantonment to the Powder Works factories	1	5,960	2	4	47,680
Solid feet filling in Trench.....					101,216
			Area.		
Deduct on account of pipes	1	6,692	1·30		8,699·60
	1	5,960	0·95		5,662·00
Total solid feet deduction for pipes....					14,361·60

Cast-iron pipe.	Length.	Weight. Tons.	Cwt.	Qrs.	Lbs.
From the expense reservoir at Gunesh Khind to the Kirkee Cantonment, diameter 14 inches and thickness $\frac{7}{8}$ths of an inch	6,692	359	2	2	27
From the Kirkee Cantonment to the Powder Works factories, diameter 12 inches and thickness $\frac{7}{8}$ths of an inch	5,960	228	16	1	0
		587	18	3	27
Add for leakage at 5 per cent		29	6	3	22
Total weight of cast iron pipe....		617	5	3	21

Sundry Works.	Number.
Scouring and air valves	4
Total number of valves.....	4

ABSTRACT.

Quantities.	Items.	Amount. Rs.	a.	p.
101,216	Solid feet excavation in various sorts of soil, at Rs. 2 per 100 solid feet	2,024	5	1
86,854·4	Solid feet filling in trench, at 4 annas per 100 solid feet	217	2	1
617½	Tons of cast iron pipe, at Rs. 160 per ton	98,760	0	0
4	Number scouring and air valves, at Rupees 100 per each	400	0	0
		1,01,401	7	2
	Contingencies at 5 per cent.	5,070	1	2
	Establishment	360	0	0
	Total Rupees for laying main pipe	1,06,831	8	4

DISTRIBUTION IN THE KIRKEE CANTONMENT.

Description.

The small expense reservoirs at the Kirkee Barracks, in the Officers' Lines, and Bazar at Kirkee, will be made large enough to store two days' supply for each purpose, and that for the Arsenal and Powder Works will be situated on the site of the proposed fort, and will probably form a part of the fort ditch. The water for horse trough and plunge bath, is to be conducted from the main by a branch pipe 3 inches in diameter, and to the Hospital, Barracks, Patcheries, Canteen, &c., by stand cocks attached to the ends of branch pipes, 3 inches in diameter, which will be secured in recesses under lock and key. For further details *see* Plans and Estimates.

Measurements.

Excavation for foundation.	Number.	Length.	Breadth.	Depth.	Cubic Feet.
Reservoir in the Government House garden	1	32	32	7	7,168
Do. 26 feet by 26 feet by 5 feet in the Officers' Lines	1	24	24	7	4,032
Do. near the Barracks, 27 feet diameter	1	572·5		4	2,290
Do. in the Bazar, 22 feet by 22 feet by 5 feet	1	28	28	7	5,488
Do. in the Arsenal, 26 feet by 26 feet by 5 feet	1	32	32	7	7,168
Total cubic feet of excavating foundation					26,146

Superstructure, of coursed rubble masonry, faced with cutstone work.	Number.	Length.	Breadth.	Depth.	Cubic Feet.
Lining of the reservoir in the Government House.....	1	137	2·25	7	2,157·75
Do. Pavement	1	32	32	2	2,048·00
Lining of the reservoir in the Officers' Lines	1	105	2·25	7	1,653·75
Do. Pavement	1	24	24	2	1,152·00
		Area			
Lining of the reservoir near the Barracks	1	216·77		11	2,384·47
Do. Pavement	1	314·16		2	628·32
Lining of the reservoir in the Bazar	1	131	2·25	7	2,063·25
Do. Pavement	1	28	28	2	1,568·00
Lining of the reservoir in the Arsenal	1	137	2·25	7	2,157·75
Do. Pavement	1	32	32	2	2,084·00
Total cubic feet faced with cutstone....					17,861·29

Cutstone work of parapet walls, including coping.					
To the reservoir in the Government House.....	1	119	3	1½	535·50
Do. in the Officers' Lines.	1	78	3	1½	351·00
		Area			
Do. near Barracks	1	216·77		1	216·77
Do. in the Bazar	1	94	3	1½	423·00
Do. in the Arsenal	1	119	3	1½	535·00
Total cubic feet cutstone masonry....					2,061·27

Pavement around the Reservoir.	Number.	Length.	Breadth.	Square Feet.
To the reservoir in the Government House.	1	128	3	384
Do. in the Officers' Lines....	1	96	3	288
		Area		
Do. near the Barracks	1	260		260
Do. in the Bazar	1	112	3	336
Do. in the Arsenal	1	128	3	384
Total square feet pavement				1,652

Cast-iron branch pipe, 3 inches in diameter.	Length.	Total Weight.			
		Tons.	Cwt.	Qrs.	Lbs.
Government House	800	4	17	3	8·8
Plunge bath and horse trough	1,530	9	7	0	10·8
To the Officers' Lines....	1,210	7	7	3	24·1
To the Bazar	1,580	9	3	0	23·6
To Barracks, Hospital, Canteen, &c.	2,000	12	4	2	8·0
To the Arsenal	1,000	6	2	1	4·0
Add for breakage, at 5 per cent. ..	406	2	9	2	20·7
Total weight of pipe (branch)..		52	2	2	16·

Miscellaneous Items.	Number.
Stand cocks with recesses under lock and key	20
Total....	20

ABSTRACT.

Quantities.	Items.	Amount. Rs.	a.	p.
26,146	Cubic feet excavation in moorum and rock, at Rs. 4 per 100 cubic feet	1,046	0	0
17,851	Cubic feet superstructure of coursed rubble masonry, faced with cutstone, at Rs. 50 per do.	8,930	0	0
2,061	Cubic feet cutstone work, at Rs. 1 per foot ..	2,061	0	0
1,652	Square feet cutstone pavement, at Rupees 5 per 10 square feet.....	826	0	0
52·25	Tons of cast iron pipe, at Rs. 15 per ton.....	7,837	0	0
20	No. stand cocks with recesses under lock and key, at Rs. 100 each	2,000	0	0
	Total....Rupees	22,700	0	0
	Contingencies at 5 per cent.....	1,135	0	0
	Extra Establishment :—			
	Two carcoons for one year at Rupees 20 per mensem.....	480	0	0
	Four muckadums for one year at Rupees 10 per mensem	480	0	0
	Grand Total for distribution in the Kirkee Cantonment..	24,795	0	0

DISTRIBUTION IN THE POWDER WORKS FACTORIES.

For the Powder Works four cisterns will be constructed, at the points shown in the Plan received from Messrs. Hall & Co. These cisterns to be situated in the Powder Works enclosure, and for the purpose mentioned below. Cast iron pipe, slide cocks, and hydrants will be provided, as stated by Messrs. Hall & Co. in their list of requirements.

MEASUREMENTS.

	Number.	Length.	Breadth.	Depth.	SOLID FEET.
Excavation in rock.					
		Area.			
Fountain at the centre of enclosure wall	1	572		7	4,004
Reservoir for keeping ground wet..	1	156	156	7	1,70,352
Do. near the store shed	1	32	32	7	7,168
Do. near the glazing house..	1	32	32	7	7,168
Laying pipe	1	5,535	32	4	44,280
Total solid feet excavation in soft rock.....					2,32,972
Superstructure, of coursed rubble masonry, faced with cutstone work.					
Lining of the fountain	1	83	2·25	7	1,307·25
		Area.			
Pavement	1	572		2	1,144
Lining of the reservoir for keeping ground wet	1	633	2·25	7	9,969·75
Pavement	1	156	156	2	48,672
Do. of do. near store shed..	1	137	2·25	7	2,157·75
Pavement	1	32	32	2	2,048·00
Do. of do. near glazing house	1	137	2·25	7	2,157·75
Pavement	1	32	32	2	2,048·00
Total solid feet superstructure.....					69,509·50

Cutstone wall, including coping.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Fountain in the centre of enclosure.	1	216	3	1½	5,193
Reservoir for keeping ground wet..	1	630	3	1½	2,835
Do. near stove shed	1	119	3	1½	535·50
Do. near glazing house.....	1	119	3	1½	535·50
Total solid feet cutstone parapet.....					9,099·00

Pavement around the Reservoir.	Number.	Length.	Breadth.	Square Feet.
		Area.		
Fountain.....	1	260		260
Reservoir for keeping ground wet.....	1	636	3	1,908
Do. near stove shed	1	128	3	384
Do. near glazing house.....	1	128	3	384
Total square feet pavement				2,936

Cast iron pipe slide cocks and hydrants.	Length.	Weight.			
		Tons.	Cwt.	Qrs.	Lbs.
Pipe, 7 inches diameter and ½ inch thick	1,870	34	2	3	0
Do. 5 ditto ditto ..	2,125	28	9	0	19
Do. 4 ditto ditto ..	540	6	4	1	7
Total weight....		68	16	0	26
Add for breakage....		3	8	3	7
Total weight		72	5	0	5

Miscellaneous articles.

1	Slide cock,	7 inches	diameter,	in the reservoir.
2	Ditto	7 inches	do.	at 3-way branch entrance of Factory.
2	Ditto	5 inches		ditto ditto.
1	Ditto	5 inches	do.	at the fountain.
2	Ditto	4 inches	do.	for the two engines of Incorporating Mill.
1	Ditto	4 inches	do.	near the reservoir of dry stove shed.
1	Ditto	4 inches	do.	distant basin yard 12 horse power engine.
1	Ditto	2½ inches	do.	for the 8 horse power engine at the Composition Mills.
1	Ditto	2½ inches	do.	for the proposed engine at the workshops.
1	Ditto	2½ inches	do.	for refinery shed.
1	Ditto	2½ inches	do.	for 8 horse power engine, corning shed.
1	Ditto	3 inches	do.	for 12 horse power engine of glazing house.
15	Total No.			

ABSTRACT.

Quantities.	Items.	Amount. Rs.	a.	p.
232,972	Solid feet excavation in rock, at Rs. 4 per 100 cubic feet	9,318	14	0
69,509	Solid feet superstructure, at Rs. 30 per 100 cubic feet	20,852	11	2
9,099	Solid feet cutstone work, at Rs. 1 per foot	9,099	0	0
2,936	Square feet cutstone work, at Rs. 30 per 100 square feet	880	12	9
72·25	Tons of cast iron pipe at Rs. 160 per ton	11,560	0	0
15	Number of slide cocks, &c., at Rs. 80 each	1,200	0	0
	Total Rs.	52,911	5	11
	Contingencies at Rs. 5 per cent.	2,645	9	1
	Establishment:—			
	Two carkoons for 18 months at Rs. 20 per mensem	360	0	0
	Four muccadums for 18 months at Rs. 10 per mensem	360	0	0
	Grand Total Rs. for distribution in the Powder Works factories.	56,277	0	0

(Signed) J. G. FIFE, Lieut.-Colonel, R.E.,
Superintending Engineer for Irrigation.

V.—Miscellaneous Public Improvements.

Poona and Kirkee Water Supply.

ESTIMATE No. 2 OF 1865-66.

ESTIMATE framed by Lieutenant Colonel J. G. FIFE, *Superintending Engineer for Irrigation, of the Probable Expense of constructing an Aqueduct of* 3 *ten-feet spans, on the Kirkee Canal line. Estimate framed agreeably to the instructions contained in Government Resolution No.* $\frac{536 \text{ C.W.}}{1504 \text{ of } 1865,}$ *dated* 13*th July* 1865, *and Government Resolution No.* $\frac{213 \text{ M.W.}}{1733 \text{ of } 1865,}$ *dated* 10*th August* 1865.

Amount of Estimate, Rs. 1,745-12-7.

GENERAL DESCRIPTION.

The aqueduct to be of 3 segmental arches of 10 feet span, 2·5 feet rise, and 1' foot thickness of arching; abutments to be 2·5 feet thick; piers 2·0 feet thick, with cutwaters on up and down stream sides. Wing walls to be partly straight and partly curved, with a mean thickness of $\frac{1}{4}$th of the height. Parapet to be 1·75 feet broad at bottom and ·75 foot at top. Water channel to be eight feet wide at bottom and ten feet wide at the top, having a concrete bedding below.

CONSTRUCTION.

Excavation for foundation in hard moorum. Filling in of rubble stone and lime. Superstructure of coursed stone and lime. Parapets of well burnt brick and lime; arching of stone slabs, with facing voussoirs, chisel dressed. Newel and starling caps to be of 2nd sort cutstone. String course of 2nd sort cutstone.

MEASUREMENTS.

Excavation for foundation in hard moorum.	Number.	Length.	Breadth.	Depth.	SOLID FEET.
Abutments	1	13·5	4·5	4·5	273·37
Do.	1	18·5	4·5	4	333·00
Piers	2	17	3·5	2·5	297·50
Wing walls, left side	2	30·83	3·75	2 62	605·80
Do. right side	2	30·83	3·75	3	693·67
Newels	4	0·75	0·75	3·75	8·43
Total solid feet excavation for foundation....					2,211·77
Filling in of rubble stone and lime.					
Abutments	2	13·5	4·5	0·75	91·12
Do.	2	12·5	3·5	0·75	65·62
Piers	2	11·5	3·5	0·75	60·37
Do.	2	11·5	2·5	0·75	43·12
		Area			
Cutwaters	4	3·84		0·75	11·52
Do.	4	2·46		0·75	7·38
Wing walls, left side	2	30·83	3·5	2·62	565·42
Do. right side	2	30·83	3·5	3·00	647·43
Newels	4	0·75	0·75	3·75	8·43
Total solid feet filling in of stone and chunam....					1,500·41
Superstructure of coursed stone and lime.					
Abutments	2	11·5	2·5	4·25	244·37
Piers	2	11·5	1·5	3·5	120·75
		Area			
Cutwaters	4	1·39		3·5	19·46
Spandril walls	2	41·83		2	167·32
Portion of wing walls between foundation and parapets	1	30·83	2·62	4·5	363·48
Ditto do.	1	30·83	2·62	4·25	343·29
Newels at the end of wing walls..	4	·75	·75	8·5	19·12
Total cubic feet superstructure....					1,277·79

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Arch-work.		Area.			
Rings, including cutstone face voussoirs	3	13		11·5	448·5
Total cubic feet arch-work					448·5
Backing, of rubble and lime.		Area.			
Over abutments and piers	1	41·83		7·5	213·72
Total solid feet backing					213·72
Parapet walls.					
1st portion	2	38·00	2·25	0·5	85·50
2nd do.	2	99·66	1·25	2·5	622·87
3rd do.	2	76·66	1·25	2	383·30
Total solid feet parapets, of brick and lime					1,091·67
Concrete.					
Bottom of channel	1	38	8	0·50	152
Total solid feet concrete bedding					152
Skew backs.					
Over abutments	2	11·5	2·12	0·96	46·80
Do. piers	2	11·5	·75	0·96	16·56
Total solid feet skew backs					63·36

Starling caps.	Number.
Over cutwaters	4
Total No. of starling caps	4

Newel caps.	
Over top of newels	4
Total No. of newel caps	4

String course.	Number.	Length.	Running Feet.
Round abutments	2	16·5	33
Do. piers	2	28·5	57
Total running feet string course			90

Chunam plaster.	Number.	Length.	Breadth.	Square Feet.
Inside of parapets, 1st portion	2	99·66	2·50	498·30
Do. do. 2nd do.	2	76·66	2·00	306·64
Total square feet chunam plaster				804·94

Chunam pointing.	Number.	Length.	Breadth.	Depth.	Superficial Feet.
Outside of parapets, 1st portion	2	99·66	....	2·50	498·30
Do. do. 2nd do.	2	76·66	....	2·00	306·64
Total superficial feet chunam pointing					804·94

Embanking.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Between straight portions of wings.	1	23	6·25	4	575·00
		Area.			
Do. curved portions	2	181·41		8·5	3,084·60
Do. do. exterior ..	4	91·6		10	3,666·00
Total solid feet embanking....					7,025·00

Centering.					
		Area.			
Circular portion	3	17·47		11·5	602·71
Rectangular portion	1	7·75	10	11·5	891·25
Total solid feet centering					1,493·96

ABSTRACT.

Quantities.	Items.	Amount. Rs. a. p.
2,212	Solid feet excavation for foundation in hard moorum, at Rs. 1 per 100 cubic feet	22 1 11
1,500	Solid feet filling in of rubble stone and lime, at Rs. 16 per 100 solid feet	240 0 0
1,278	Solid feet superstructure, of coursed stone and lime, at Rs. 20 per 100 solid feet	255 9 7
448·5	Solid feet arch work of stone slabs, with 2nd sort cutstone facing, at Rs. 40 per 100 solid feet	179 6 4
214	Solid feet backing, of rubble stone and lime, at Rs. 16 per 100 solid feet	34 3 10
1,091	Solid feet parapet walls of burnt brick and lime, at Rs. 25 per 100 solid feet	272 12 0
152	Solid feet concrete, for bedding, at Rs. 15 per 100 solid feet	22 12 9
63	Solid feet skew backs, at Rs. 30 per 100 solid feet	18 14 4
	Carried over....Rupees	1,045 12 9

ABSTRACT—*continued.*

Quantities.	Items.	Amount. Rs.	a.	p.
	Brought forward....Rupees	1,045	12	9
4	Number of starling caps at Rs. 5 each	20	0	0
4	Newel caps at Rs. 4 each	16	0	0
90	Running feet string course, at Rs. 2 per foot ..	180	0	0
805	Superficial feet chunam plaster, at Rs. 5 per 100 superficial feet	40	4	0
805	Superficial feet chunam pointing, at Rs. 4 per 100 superficial feet	32	3	2
7,025	Solid feet embanking, at 3 annas per 100 do. ..	35	2	0
1,494	Solid feet centering, at Rs. 16 per 100 cubic feet.	239	0	0
	Total Rs....	1,608	5	11
	Add contingencies at 5 per cent. ..	80	6	8
	Total Rupees.....	1,688	12	7
	Add for extra Establishment:—			
1	Carcoon for 1½ months at Rs. 20 per mensem.....	30	0	0
1	Moocadum for 1½ months at Rs. 10 per mensem....	15	0	0
1	Chowkeedar for 1½ months at Rs. 8 per mensem....	12	0	0
	Grand Total .....Rupees	1,745	12	7

(Signed) J. G. FIFE, Lieut. Colonel, R.E.,
Superintending Engineer for Irrigation.

V.—Miscellaneous Public Improvements.

Poona and Kirkee Water Supply.

ESTIMATE No. 2 of 1865-66.

ESTIMATE framed by Lieutenant Colonel Fife, *Superintending Engineer for Irrigation, of the Probable Cost of constructing an Aqueduct of* 5 *segmental arches of* 15 *feet span. Estimate framed agreeably to the instructions contained in Government Resolution No.* $\frac{536 \text{ CW}}{1504 \text{ of } 1865}$, *dated* 13*th July* 1865, *and Government Resolution No.* $\frac{213 \text{ MW}}{1733 \text{ of } 1865}$, *dated* 10*th August* 1865.

General Description.

The aqueduct to consist of 5 fifteen feet arches. Rise 3·75 feet. Thickness of archring 1·25 feet. Abutments to be 3·75 feet thick. Piers to be 2·25 feet. Wing walls to be partly straight and partly curved, having a mean thickness equal to one-fourth of the height. Parapets to be 1·75 feet thick at bottom, and ·75 foot at top. Water channel 8 feet broad at bottom, and 10 feet at top, and to have six inches bedding of concrete below.

Construction.

Excavation for foundation in moorum and earth. Filling in of rubble stone and chunam. Superstructure of coursed stone and chunam. Arching of stone slabs with 2nd sort cutstone facing. Parapets of burnt brick and chunam. String course to be 2nd sort cutstone round abutments and piers. Embanking of earth in layers of 1 foot thick, well rammed.

MEASUREMENTS.

	Number.	Length.	Breadth.	Depth.	SOLID FEET.
Excavation for Foundation.					
Abutments, left side	1	13·5	5·75	5·00	388·12
Do. right side	1	13·5	5·75	5·75	446·34
Piers	4	18	4·25	2·50	765·00
Wing walls, 1st portion, left side	2	8·50	4	3·25	221·00
Do. 2nd do. do.	2	2·00	3·5	2·25	31·50
Do. curved do.	2	17·67	3·5	2·75	340·14
Do. right side	2	8·00	3·75	2·50	150·00
Do. curved, do	2	17·47	3·25	2·50	283·88
Newels at the ends of wings	4	0·75	0·75	3·00	6·75
Total cubic feet excavation in earth and moorum					2,632·73

Filling in of rubble stone and lime.					
Abutments	2	13·5	5·75	·75	116·43
Do.	2	12·5	4·75	·75	89·06
Piers	4	11·5	4·25	·75	146·6
Do.	4	11·5	3·25	·75	112·12
		Area.			
Cutwaters, 1st step	8	11·14		·75	66·84
Do. 2nd do.	8	8·64		·75	51·84
Wing walls, left side	2	9·5	3·59	3·25	221·68
Do. do.	2	2	3·22	2·25	28·98
Do. right side	2	9	3·18	2·5	143·10
Circular portion, left side	2	17·55	3·59	2·75	346·50
Do. do. right do.	2	17·22	2·93	2·50	252·27
Newels at the end of wing walls	4	·75	·75	3	6·75
Total solid feet filling in foundation with rubble stone and lime					1,582·17

Superstructure of coursed stone and chunam.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Abutments	2	11·5	3·75	4·25	366·56
Piers	4	11·5	2·25	4·25	439·90
		Area			
Cutwaters	8	3·13		4·25	106·40
Wingwalls, left side, 1st step	2	9·5	2·5	4·25	201·87
Do. do. 2nd do.	2	2	2·5	3·75	37·50
Do. do. curved portion	2	16·88	2·5	3·75	316·50
Do. right side, straight portion	2	9	2·5	4·5	202·50
Do. do. curved „	2	16·83	2·25	2·5	189·33
Newels at the ends of wings	4	·75	·75	7·5	16·87
		Area			
Spandril walls	2	147·80		2	591·20
Total solid feet superstructure of coursed stone and lime					2,468·63

Arching.		Area.		
Archrings, with cut stone voussoirs	5	22·40	11·5	1,288·00
Total solid feet archwork of slab stones				1,288·00

Backing, of rubble and lime.		Area.		
Over abutments and piers	1	147·80	7·5	1,108·5
Total solid feet backing				1,108·5

Concrete bedding.					
For bedding of channel	1	91·5	7·5	0·5	343·12
Total solid feet concrete bedding					343·12

Parapets, of brick and lime.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Bottom portion	2	92	2·25	·5	207·00
1st portion	2	143·5	1·25	2·5	896·87
2nd do.	2	74·5	·75	2	223·50
Total solid feet parapet walls					1,327·37

String course.	Number.	Length.	Breadth.	Depth.	Running Feet.
Round abutments	2	19	..	..	38
Do. piers	4	20·92	..	..	83·68
Total running feet string course					121·68

Starling caps.	Number.
On tops of cutwaters	8
Total No. of starling caps	8

Newel caps.	
On tops of newels	4
Total No. of newel caps	4

Skew backs.	Number	Length.	Breadth.	Depth.	Solid Feet.
Over abutments	1	11·5	6·5	1	74·75
Do. piers	4	11·5	Area. 1·125		51·75
Total solid feet skew backs.....					126·50

Chunam plaster.	Number.	Length.	Depth.	Superficial Feet.
Inside of parapets, 1st portion.....	2	143·5	2·5	717·50
Do. do. 2nd portion.....	2	74·5	2·00	298·00
Total superficial feet chunam plaster.....				1,015·50

Chunam pointing.	Number.	Length.	Depth.	Square Feet.
Outside of parapets, 1st portion	2	143·5	2·5	717·50
Do. do. 2nd portion	2	74·5	2·00	298·00
Total square feet chunam pointing.....				1,015·50

Embanking, of earth.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Between straight portions of wings.	1	19	7	5·00	665·00
Between curved portions, interior..	2	Area. 181·41		8·50	3,084·00
Between exterior, right.....	2	117·50		9·00	2,115·00
Between do. left	2	84·90		8·25	1,480·85
Total solid feet embanking of earth.....					7,344·85

	Number.	Length.	Breadth.	Depth.	Cubic Feet.
Centering.		Area.			
Curved portion	5	39·31		11·5	2,260·32
Straight rectangular	5	15	3·5	11·5	3,018·75
				Total cubic feet centering	5,279·07

ABSTRACT.

Quantities.	Items.	Amount.		
		Rs.	a.	p.
2,633	Solid feet excavation in moorum and earth, at 1 Rupee per 100 solid feet.....	26	5	3
1,582	Solid feet filling in of rubble stone and lime, at Rupees 16 per 100 solid feet...	253	1	11
2,469	Solid feet superstructure, of coursed stone and chunam, at Rupees 20 per 100 solid feet	493	12	9
1,288	Solid feet arch work, with facing of 2nd sort cut-stone voussoirs, at Rupees 40 per 100 solid feet	515	3	2
1,109	Solid feet backing, of rubble and lime, at Rupees 16 per 100 solid feet	177	7	0
343	Solid feet bedding for channel, of concrete, at Rupees 15 per 100 solid feet	51	7	2
1,327	Solid feet parapets, of brick and lime, at rupees 25 per 100 solid feet	331	12	0
	Carried forward..	1,849	1	3

ABSTRACT—*continued*.

QUANTITIES.	ITEMS.	AMOUNT. Rs.	a.	p.
	Brought forward	1,849	1	3
122	Running feet string course, of 2nd sort cutstone, at Rs. 2 per foot	224	0	0
8	No. of starling caps, at Rs. 5 each	40	0	0
4	Newel caps, at Rs. 4 each.....	16	0	0
127	Solid feet skew backs, at Rs. 30 per 100 solid feet	38	1	7
1,016	Superficial feet chunam plaster, at Rs. 5 per 100 superficial feet	50	12	9
1,016	Superficial feet chunam pointing, at Rs. 4 per 100 do.	40	10	3
5,279	Solid feet centering, at Rs. 16 per 100 solid feet	804	10	2
7,345	Solid feet embanking at 8 annas per 100 do. ..	36	11	6
	Total .... Rupees	3,119	15	6
	Add 5 per cent. for contingencies	156	0	0
	Extra Establishment :—			
	1 Carkoon for 2½ months, at 20 Rs. per month.	50	0	0
	2 Mookadums for do. at 10 Rs. per do.	50	0	0
	1 Chowkeedar for do. at 8 Rs. per do.	20	0	0
	Grand Total .... Rupees	3,395	15	6

(Signed) J. G. FIFE, Lieut. Colonel, R.E.,
Superintending Engineer for Irrigation.

V.—Miscellaneous Public Improvements.

Poona and Kirkee Water Supply.

ESTIMATE No. 2 OF 1865-66.

ESTIMATE framed by Lieutenant Colonel FIFE, *Superintending Engineer for Irrigation, of the Probable Expense of constructing seven Aqueducts of one* 20 *feet span, on the Kirkee Canal line. Estimate framed agreeably to the instructions contained in Government Resolutions No.* $\frac{536 \text{ C. W.}}{1504 \text{ of } 1865}$, *dated* 13*th July* 1865, *and* $\frac{213 \text{ M. W.}}{1733 \text{ of } 1865}$, *dated* 10*th August* 1865.

Amount of Estimate, Rs. 9,621-8-0

GENERAL DESCRIPTION.

The aqueduct is to be of one 20 feet span. Rise 5 feet. Thickness of archring 1·5 feet. Thickness of abutments 5 feet. Thickness of wing walls 2 feet at top, with a batter in the rear of $\frac{1}{4}$th of the height. Parapets to be 1·75 feet thick at bottom and ·75 foot at top. Channel at bottom to be 8 feet broad, at top 10 feet.

CONSTRUCTION.

Excavation for foundation in deep black soil. Filling in of rubble stone and lime. Superstructure of coursed stone and chunam. Parapets of burnt brick and lime. String course and newel caps of 2nd sort cutstone. The channel to have concrete bedding. Embankments to be of earth, in one foot layers, well rammed.

MEASUREMENTS.

Excavation for foundation.	Number.	Length.	Breadth.	Depth.	SOLID FEET.
Abutments	2	12·5	6	8·75	1,312·50
Wing walls, left, straight portions..	2	5·00	3·25	2·50	81·25
Do. do. do.	2	2·75	3 25	2	33·75
Do. do. circular portions..	2	17·15	3·25	1·75	195·08
Do. right, straight	2	7	3·25	2·87	130·58
Do. do. curved, 1st portion	2	5·5	3·25	4	143·00
Do. do. 2nd do...	2	11·65	3·25	2·62	198·39
Newels at the end of wings	4	·75	·75	2·75	6·18
Total solid feet excavation in deep black soil					2,100·73

Filling in of rubble stone and lime.					
Abutments	2	12·5	6	·75	112·50
Wing walls, left, straight, 1st portion.	2	2·75	3·18	2	34·98
Do. do. curved	2	17·10	3·18	2·87	312·12
Do. straight, 2nd portion..	2	5	3·25	2·5	81·25
Do. right, straight	2	7	3 25	2·87	130·56
Do. do. curved	2	17·15	3·25	4	445·90
Newels at the ends of wings	4	·75	·75	2·75	6·58
Total solid feet filling in of rubble stone and lime					1,123·89

Superstructure, of coursed rubble and lime.					
Abutments	2	11·5	5	6	690·00
Wing walls, left, straight, 1st portion.	2	5	2·96	4·25	125·80
Do. do. 2nd do...	2	2·75	2·89	4·75	75·50
Do. right, straight	2	7	2·98	3·88	161·87
Do. curved, left	2	17	2·88	3·88	379·90
Do. do. right	2	17	2·68	2·75	250·58
Newels at the ends of wings	4	·75	·75	7·7 5	17·43
		Area.			
Spandril walls	2	68·47		2	273·88
Total solid feet superstructure of coursed stone and lime..					1,974·96

Arching.	Number.	Length.	Breadth.	Depth.	Solid Feet.
		Area.			
Ring, with cutstone face voussoirs .	1	29·83		11·5	343·04
Total solid feet slab stone arching					343·04

Backing.					
		Area.			
Over abutments.....	1	68·47		7·50	513·52
Total solid feet backing of rubble and lime.....					513·52

Concrete.					
Bottom of water channel	1	30	8	·75	180
Total solid feet concrete					180

Parapet walls.					
Bottom portion	2	30	2·25	0·50	67·50
Both sides of the channel, 1st portion	2	77·08	1·25	2·50	481·75
Do. do. 2nd portion	2	66·32	·75	2·00	198·96
Total solid feet parapets of burnt brick and lime....					748·21

Pointing.	Number.	Length.	Breadth.	Depth.	Superficial Feet.
Parapet walls, outside	2	77·08	3	..	462·48
Do. do.	2	66·32	2	..	265·28
Total superficial feet chunam pointing					727·76

Chunam plaster.	Number.	Length.	Breadth.	Superficial Feet.
Parapets, inside	2	17·08	3	462·48
Do. do.	2	66·32	2	265·28
Total superficial feet chunam plaster				727·76

Skew backs.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Over abutments	2	11·5	·62	1·25	17·82
Total solid feet skew backs					17·82

Newel caps.	Number.
On top of newels	4
Total No. of newel caps	4

Embanking.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Between straight portions of wings	1	15·5	7·25	3	337·12
		Area			
Do. circular do. do.	2	316·68		5	3,166·80
Do. exterior	4	85·63		9·00	3,082·68
Total solid feet embanking					6,586·60

Centering.				
Curved portion	1	69·89	11·5	803·73
Total solid feet centering				803·73

ABSTRACT.

Quantities.	Items.	Amount. Rs.	a.	p.
2,101	Solid feet excavation for foundation in deep soil, at 1 Rupee per 100 solid feet.....	21	0	1
1,124	Solid feet filling in of rubble and lime, at Rs. 16 per 100 feet.....	179	13	5
1,975	Solid feet superstructure, of coursed stone and lime, at Rs. 20 per do.	395	0	0
343	Solid feet arching, of stone slabs, at Rs. 40 per 100	137	3	2
514	Solid feet backing of rubble and lime, at Rs. 16 per do.	82	3	10
180	Solid feet concrete, at Rs. 15 per do.	27	0	0
748	Solid feet parapets, of burnt brick and lime, at Rs. 25 per 100 solid feet.....	187	0	0
728	Superficial feet chunam pointing, at Rs. 4 per 100 superficial feet	29	1	11
728	Superficial feet chunam plaster, at Rs. 5 per 100 solid feet	36	6	5
16	Solid feet skew backs, at Rs. 30 per 100 solid feet	5	6	4
4	No. of newel caps, at Rs. 4 each	16	0	0
65·82	Solid feet embanking of earth, at Rs. 8 per 100 solid feet	32	14	6
803	Solid feet centering, including wooden frames, at Rs. 16 per 100 cubic feet	128	7	8
	Total....Rupees	1,278	9	4
	Add contingencies at 5 per cent.	63	14	8
	Total....Rupees	1,342	8	0
	Extra Establishment :—			
	1 Carkoon for 1 month at Rs. 15 per month..	15	0	0
	1 Mookadum for do. at Rs. 9 per do. ..	9	0	0
	1 Chowkeedar for do. at Rs. 8 per do. ..	8	0	0
	Grand Total cost, for one aqueduct ..	1,374	8	0
	Total of Rupees for seven aqueducts of the same kind..	9,621	8	0

(Signed) J. G. FIFE, Lieut. Colonel, R.E.,
Superintending Engineer for Irrigation.

V.—Miscellaneous Public Improvements.

Poona and Kirkee Water Supply.

ESTIMATE No. 2 of 1865-66.

ESTIMATE framed by Lieutenant Colonel Fife, *Superintending Engineer for Irrigation, of the Probable Cost of constructing six Aqueducts of two twenty-feet spans, on the Kirkee Canal line. Estimate framed agreeably to the instructions contained in Government Resolutions, Nos.* $\frac{536\ CW}{1504\ of\ 1865}$, *dated 13th July* 1865, *and* $\frac{213\ MW}{1733\ of\ 1865}$, *dated 10th August* 1865.

Amount of Estimate, Rs. 12,099-15-6.

General Description.

The aqueduct is to be of 2 spans of 20 feet. Rise 5 feet. Thickness of abutments to be 5 feet. Thickness of piers 3 feet. Wing walls to be 2 feet thick at top, with a batter on the inside $\frac{1}{4}$th of the height. Parapets to be 1·75 feet thick at bottom, and 9 inches at top. Water channel to be 8 feet at bottom and 10 feet at top, with a 6 inches bedding of concrete below.

Construction.

Excavation for foundation in moorum. Filling in of rubble stone and lime. Superstructure of coursed stone and lime. Parapets to be of burnt brick and lime. Starling caps, string course, and newel caps to be of 2nd sort cutstone. Embankment of earth in layers of 1 foot thick.

MEASUREMENTS.

Excavation for foundation.	Number.	Length.	Breadth.	Depth.	SOLID FEET.
Abutments	2	13·50	7	5·75	1,086·75
Piers	1	18·50	5	2·50	231·25
Wingwalls, left, 1st portion	2	3·75	3·37	1·75	44·22
Do. do. 2nd do.	2	3·75	3·25	1·75	42·30
Circular portion	2	17·47	3·25	1·75	198·72
Wingwalls, right, straight portion	2	7·25	3·50	2·50	126·87
Do. do. circular do.	2	17·67	3·50	2·50	309·22
Newels at the ends of wings	4	·75	·75	2·62	5·90
Total cubic feet excavation for foundation					2,045·23
Filling in of rubble stone and lime.					
Abutments	2	13·50	7	·75	141·35
Do.	2	12·50	6	·75	112·50
Piers	1	11·50	6	·75	51·75
Do.	1	11·50	5	·75	43·12
Wingwalls, left	2	4·75	3·15	1·75	52·36
Do. do. straight portions	2	3·75	3·03	1·75	39·76
Do. do. curved do.	2	17·12	3·03	1·75	181·55
Do. right, straight portion	2	8·25	3·18	2·50	131·17
Do. do. circular do.	2	17·17	3·18	2·50	273·00
Newels	4	·75	·75	2·62	5·90
		Area.			
Cutwaters, 1st step	2	9·33		·75	14·70
Do. 2nd do.	2	7·52		·75	11·20
Total solid feet filling in of rubble and lime					1,058·36
Superstructure.					
Abutments	2	11·50	5	1·75	201·25
Piers	1	11·5	3	1·75	60·37
		Area.			
Cutwaters	2	5·52		1·75	19·32
Wing walls, left, straight	2	4·75	2·47	3·50	82·12
Do. do. do.	2	3·75	2·40	3·25	58·50
Curved do.	2	16·31	2·40	3·25	262·23
Wingwalls, right, straight	2	8·25	2·43	3·50	140·13
Curved do.	2	16·95	2·43	3·50	288·39
		Area.			
Spandril walls	2	140·02		2	560·00
Newels	4	·75	·75	7·88	17·73
Total solid feet superstructure of coursed stone and lime					1,690·04

Arching.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Rings, including cutstone faced voussoirs	2	Area 31·80		11·50	731·40
Total solid feet arch work of stone slabs....					731·40

Backing.					
Over abutments and piers.....	1	Area 140·02		7·50	1,050·15
Total solid feet backing, rubble stone and lime....					1,050·15

Skew backs.					
Over abutments	2	11·5	0·62	1·25	17·82
Do. piers	2	11·5	0·62	1·25	17·82
Total solid feet skew backs.....					35·64

Concrete.					
Bottom of channel.....	1	53	8·	·5	212
Total solid feet concrete					212

Parapets.					
Curved portion	4	16·29	1·25	3	244·35
Do. do.	4	15·91	·75	2	95·46
Straight, 1st portion	2	69·75	1·25	3	523·12
Do. do.	2	46·75	·75	2	140·25
Solid feet parapets of brick and chunam					1,003·18

Plaster.	Number.	Length.	Breadth.	Square Feet.
Inside of parapets	4	16·29	3	195·48
Do. do.	4	15·91	2	127·28
Parapets, inside	2	60·75	3	418·50
Do. do.	2	46·75	2	187·00
Total superficial feet plaster				928·26

Chunam pointing.	Number.	Length.	Breadth.	Superficial Feet.
Outside of parapets	4	16·29	3	195·48
Do. do.	4	15·91	2	127·28
Do. do.	4	69·75	3	418·50
Do. do.	2	46·75	2	187·00
Superficial feet chunam pointing				923·26

Starling caps.	Number.
On tops of cutwaters	2
Total No. of starling caps	2

Newel caps.	
On tops of newels	4
Total No. of newel caps	4

Embankment.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Between straight portions of wings	1	15·50	6·50	3·75	377·81
		Area			
Do. circular do. do.	2	125·00		8	2,000·00
Do. exterior	4	102·60		8·00	3,264·00
Total solid feet embanking					5,641·81

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Centering.		Area.			
Circular portion	2	69·89		11·5	1,607·47
Rectangular portion	1	18	·75	11·5	155·25
Total solid feet centering.....					1,762·72

	Number.	Length.	Breadth.	Running Feet.
String course.				
String course round abutment	2	21·50		43·00
Do. do. pier	1	35·56		35·56
Total running feet string course.....				78·56

ABSTRACT.

Quantities.	Items.	Amount.
		Rs. a. p.
2,045	Solid feet excavation for foundation in moorum, at Rs. 1 per 100 solid feet.....	20 7 2
1,058	Solid feet filling in foundation with stone and chunam, at Rs. 16 per 100 solid feet	169 4 5
1,690	Solid feet superstructure, of coursed rubble, at Rs. 20 per 100 feet	338 0 0
731	Solid feet arch work, including archings of 2nd sort cutstone, at Rs. 40 per 100 cubic feet ..	292 6 4
	Carried forward....	820 1 11

ABSTRACT—*continued.*

QUANTITIES.	ITEMS.	AMOUNT. Rs. a. p.
	Brought forward.....	820 1 11
1,050	Solid feet backing, of rubble masonry, at Rs. 16 per 100 cubic feet	168 0 0
36	Solid feet skew backs, at Rs. 30 per 100 do....	10 3 2
212	Solid feet concrete for the bottom of canal, at Rs. 15 per 100 cubic feet	31 12 9
1,003	Solid feet parapets, of brick and mortar, at Rs. 25 per 100 cubic feet	250 12 0
923	Superficial feet chunam pointing, at Rs. 4 per 100 do.	37 1 10
923	Superficial feet chunam plaster at Rs. 5 per 100 do.	46 6 4
2	Starling caps at Rs. 5 each	10 0 0
4	Newel caps at Rs. 4 each	16 0 0
78·56	Running feet string course, second sort cutstone, at Rs. 2 per foot	157 1 10
5,642	Solid feet embankment, at 8 annas per 100 cubic feet	28 3 4
1,763	Solid feet centering, of mud, including wooden frames, at Rs. 16 per 100 feet.....	282 1 1
	Total Rupees....	1,857 12 5
	Add 5 per cent for contingencies:—	92 14 2
	Add for extra Establishment:—	
	1 Carkoon for 2 months at Rs. 15 per month	30 0 0
	1 Moocadum, at Rs. 10 per month for 2 months.....	20 0 0
	1 Chowkeedar, at Rs. 8 per do. do.	16 0 0
	Total Rupees for one aqueduct	2,016 10 7
	Total amount of six aqueducts of the same kind..	12,099 15 6

(Signed) J. G. FIFE, Lieut. Colonel, R.E.,
Superintending Engineer for Irrigation.

V.—Miscellaneous Public Improvements.

Poona and Kirkee Water Supply.

ESTIMATE No. 2 OF 1865-66.

ESTIMATE framed by Lieutenant Colonel J. G. FIFE, *Superintending Engineer for Irrigation, of the Probable Cost of constructing an Aqueduct of* 4 *segmental arches of* 15 *feet span. Estimate framed agreeably to the instructions contained in Government Resolutions Nos.* $\frac{536 \text{ C W}}{1504 \text{ of } 1865}$, *dated* 13*th July* 1865, *and* $\frac{213 \text{ M W}}{1733 \text{ of } 1865}$, *dated* 10*th August* 1865.

Amount of Estimate, Rs. 2,524-3-1.

GENERAL DESCRIPTION.

The aqueduct is to be of 4 segmental arches of 15 feet span each, with a rise of 3·75 feet; thickness of arching 1·25 feet. Thickness of abutments 3·75 feet; of piers 2·25 feet; depth concrete coating to be 0·5 foot; wing walls to be partly straight and partly curved, with a mean thickness equal to one-fourth of the height. Parapets to be 1·75 feet at bottom, and ·75 foot at top. Breadth of channel at bottom to be 8 feet, and at top 10 feet.

CONSTRUCTION.

Excavation for foundation in hard moorum. Filling in of rubble stone and chunam. Superstructure of coursed stone and chunam. Archwork stone slabs with faced voussoirs, chisel dressed. Starling caps, newel caps, and string course to be of 2nd sort cutstone. Parapets to be of well burnt brick and chunam.

MEASUREMENTS.

Excavation for foundation in moorum.	Number.	Length.	Breadth.	Depth.	SOLID FEET.
Abutments	2	13·5	5·75	6·25	970·31
Piers, including cutwaters	3	18·0	4·25	3·25	745·87
Wing walls, left, straight portion	2	7	3·25	1·75	79·62
Do. do. curved do.	2	17·48	3·25	1·75	198·83
Do. right, straight do.	2	8·75	3·50	2·75	168·43
Do. do. curved do.	2	17·68	3·50	2·75	340·34
Newels at the ends of wings	4	·75	·75	2·50	5·62
Total cubic feet excavation in hard moorum					2,509·02

Filling in of rubble stone and lime.					
Abutments	2	13·5	5·75	·75	116·43
Do.	2	12·5	4·75	·75	89·06
Piers	3	11·5	4·25	·75	109·96
Do.	3	11·5	3·25	·75	84·09
		Area.			
Cutwaters	6	11·14		·75	50·17
Do.	6	8·64		·75	38·88
Wing walls, left side, straight	2	8	3	1·75	84·00
Do. do. curved	2	17·28	3	1·75	181·44
Do. right, straight	2	9·75	3·25	2·75	174·28
Do. do. curved	2	17·47	3·25	2·75	312 27
Newels at the ends of wings	4	·75	·75	2·5	5·62
Total cubic feet filling in foundation with rubble and lime					1,246·20

Superstructure of coursed stone and lime.					
Abutments	2	11·5	3·75	3·75	323·43
Piers	3	11·5	2·25	3·75	291·00
Cutwaters	6	3·13		3·75	70·42
Wing walls, left, straight	2	8	2·5	3·75	150·00
Do. do. curved	2	16·88	2·5	3·75	316·50
Do. right, straight	2	9·75	2·40	3·25	132·00
Do. do. curved portion	2	16·80	2·40	3·25	262·08
Newels at the ends of wings	4	·75	·75	8	18·00
		Area.			
Spandril walls	2	123·65		2	494·60
Total solid feet of superstructure					2,058·03

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Arch-work.					
Rings	4	Area. 22·40		11·50	1,030·40
Total solid feet arch rings					1,030·40
Backing.					
Over abutments and piers	1	Area. 123·65		7·5	927·37
Total solid feet backing					927·37
Concrete.					
For bed of channel	1	74·25	7·5	·5	278·43
Total solid feet concrete					278·43

	Number.	Length.	Breadth.	Depth.	Running Feet.
String course.					
Round abutments	2	19	....	....	38·00
Do. piers	3	20·92	....	....	62·76
Total running feet string course					100·76

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Parapet walls.					
Bottom portion	2	77·25	2·25	0·50	173·81
Both sides of channel, 1st portion	2	123·02	1·25	2·50	768·87
Do. do. 2nd do.	2	71·27	·75	2·00	213·81
Total solid feet parapets of brick and lime					1,156·49

Chunam plaster.	Number.	Length.	Breadth.	Superficial Feet.
Inside parapets, 1st portion	2	123·02	2·5	615·10
Do. do. 2nd do.	2	71·27	2	285·08
Total superficial feet chunam plastering				900·18

Chunam pointing.				
Outside of parapets, 1st portion	2	123·02	2·50	615·10
Do. do. 2nd do.	2	71·27	2·00	285·08
Total superficial feet pointing				900·18

Skew backs.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Over abutments	1	11·5	6·5	1	
			Area		
			1·125		74·75
Do. piers	3	11·5			38·82
Total solid feet skew backs					113·57

Newel caps.	No.
On tops of newels	4
Total No. of newel caps....	4

Starling caps.	
On tops of cutwaters	6
Total No. of starling caps..	6

Embankment.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Between straight portions of wings	1	18	6·5	3·75	438·75
		Area			
Do. curved, interior portions	2	125·00		8	2,000·00
Do. do. do.	4	86·38		8·75	3,023·30
Total solid feet embankment of earth					5,462·05

Centering.					
		Area.			
Curved portion	4	39·31		11·5	1,708·25
Rectangular do.	1	22	3·25	11·5	822·25
Total solid feet centering					2,530·50

ABSTRACT.

Quantities.	Items.	Amount. Rs.	a.	p.
2,509	Solid feet excavation for foundation, at Rs. 1 per 100 solid feet, in moorum	25	1	5
1,246	Solid feet filling in of rubble stone and lime, at Rs. 16 per 100 solid feet	199	5	9
2,058	Solid feet superstructure, of coursed stone and lime, at Rs. 20 per 100 solid feet	411	9	7
1,030	Solid feet arch work, at Rs. 40 per 100 do.	412	0	0
278	Do. concrete, at Rs. 15 per 100 feet	41	11	2
927	Do. backing, at Rs. 16 per 100 feet	148	5	1
101	Running feet string course, at Rs. 2 per foot	202	0	0
1,156·50	Solid feet parapets, at Rs. 25 per 100 solid feet	289	2	0
	Carried forward.... Rs.	1,729	3	0

ABSTRACT—*continued.*

Quantities.	Items.	Amount. Rs.	a.	p.
	Brought forward....Rs.	1,729	3	0
900	Superficial feet chunam plaster, at Rs. 5 per 100 feet	45	0	0
900	Superficial feet chunam pointing, at Rs. 4 per 100 feet	36	0	0
114	Solid feet skew backs, at Rs. 30 per 100 solid feet	34	3	2
4	No. of newel caps, at Rs. 4 each	16	0	0
6	Do. of starling caps, at Rs. 5 each	30	0	0
5,462	Solid feet earthen embankment, at As. 8 per 100 cubic feet.....	27	4	11
2,530·50	Cubic feet centering, at Rs. 16 per 100 cubic feet, of mud.....	404	14	0
	Total....Rupees	2,322	9	1
	Add 5 per cent. for contingencies	115	10	0
	Add for extra Establishment :—			
	1 Carkoon for 1½ months, at Rs. 20 per month	30	0	0
	2 Moocadams for 2 months, at Rs. 10 per do.	40	0	0
	1 Chowkeedar for 2 months at Rs. 8 per do..	16	0	0
	Grand Total....Rupees	2,524	3	1

(Signed) J. G. FIFE, Lieut. Colonel, R.E.,
Superintending Engineer for *Irrigation.*

V.—Miscellaneous Public Improvements.

Poona and Kirkee Water Supply.

ESTIMATE No. 2 of 1865-66.

ESTIMATE framed by Lieutenant Colonel Fife, *Superintending Engineer for Irrigation, of the Probable Expense of constructing an Aqueduct of 4 ten feet segmental arches, on the Kirkee Canal line. Estimate framed agreeably to the instructions contained in Government Resolutions Nos.* $\frac{536 \text{ C. W.}}{1504 \text{ of } 1865}$, *dated 13th July* 1865, *and* $\frac{213 \text{ M. W.}}{1733 \text{ of } 1865}$, *dated 10th August* 1865.

Amount of Estimate, Rs. 2,114-7-6.

General Description.

The aqueduct to be of 4 ten feet segmental arches. Rise 2·5 feet. Thickness of arching 1 foot. Abutments to be 2·5 feet thick. Piers 2 feet. Wingwalls to be partly curved and partly straight, 2 feet thick at top, and with a batter of one-fourth of the height. Parapets to be 1·75 feet thick at bottom and 0·75 foot at top.

Construction.

Excavation for foundation in hard moorum. Filling in of rubble stone and chunam. Superstructure of coursed stone and chunam. Backing of rubble stone and chunam. Parapets to be of well burnt brick and lime, pointed outside, and plastered inside. Archings to be of stone slabs with second sort cutstone voussoirs for facing; water channel to have a surface bedding of concrete 6 inches thick. Embankment to be of earth. Starling caps, newel caps, and string course to be of 2nd sort cutstone.

MEASUREMENTS.

Excavation for foundation in hard moorum.	Number.	Length.	Breadth.	Depth.	SOLID FEET.
Abutments	2	13·50	4·50	3·87	470·20
Piers	3	16·25	4·00	2·50	487·50
Wingwalls, left, straight	2	12·50	3·50	2·25	196·87
Do. do. curved	2	17·67	3·50	2·25	278·30
Do. right, straight	2	21·00	3·50	2·25	330·75
Do. do. curved	2	17·67	3·50	2·25	278·30
Newels at the ends of do.	4	·75	·75	2·75	6·18
Total cubic feet of excavation for foundation					2,048·10
Filling in, of rubble and chunam.					
Abutments	2	13·50	4·50	·75	91·12
Do.	2	12·50	3·50	·75	65·62
Piers	3	11·50	4·00	·75	103·50
Piers, 2nd step	3	11·50	3·00	·75	77·62
		Area			
Cutwaters	6	5·52		·75	24·84
2nd do.	6	3·33		·75	17·23
Wingwalls, straight portion, left	2	13·50	3·25	2·25	197·40
Do. curved portion	2	17·45	3·22	2·25	252·80
Do. right, straight	2	22·00	3·22	2·25	318·70
Do. curved portion	2	17·45	3·22	2·25	252·60
Newels at the ends of wings	4	·75	·75	2·75	6·18
Total cubic feet of filling in of rubble and chunam					1,407·61
Superstructure of coursed stone and chunam.					
Abutments	2	11·50	2·50	3·50	201·50
Piers	3	11·50	2·00	3·50	241·50
		Area			
Cutwaters	6	2·43		3·50	51·03
Spandril walls	2	51·37		2·00	205·40
Wingwalls, left side, straight	2	13·50	2·47	3·75	250·88
Do. do. curved portion	2	16·86	2·46	3·75	312·31
Do. right, straight	2	22·00	2·47	3·75	407·55
Do. do. curved	2	16·86	2·47	3·75	312·31
Newels	4	·75	·75	8·25	18·56
Total solid feet of superstructure of coursed stone and lime					2,001·04

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Arch-work.					
Rings	4	Area. 13·00		11·5	598·00
Total solid feet of arch-work, with cutstone voussoirs					598·00
Backing.					
Over abutments and piers	1	Area. 51·37		7·50	385·27
Total solid feet backing of rubble and lime					385·27
Concrete.					
For channel bed	1	51·00	8·00	·50	204·00
Total solid feet concrete bedding					204·00
Parapets.					
Bottom course of parapets	2	49·50	2·25	0·50	111·37
Both sides, 1st portion	2	116·80	1·25	2·50	730·00
Do. 2nd do.	2	81·86	·75	2·00	245·58
Total solid feet of parapets of brick and lime					1,086·95

	Number.	Length.	Breadth.	Depth.	Superficial Feet.
Chunam plaster.					
Inside of parapets, 1st portion	2	116·80	2·50	..	584·00
Do. 2nd do.	2	81·86	2·00	..	327·44
Total superficial feet chunam plaster					911·44

Chunam pointing.	Number.	Length.	Breadth.	Depth.	Superficial Feet.
Outside of parapets, 1st portion ..	2	116·80	2·50	....	584·00
Do. do. 2nd do.	2	81·86	2	....	327·44
Total superficial feet chunam pointing					911·44

String course.	Number.	Length.	Running Feet.
Round abutments	2	16·50	33·00
Do. piers	3	29·28	87·84
Running feet string course.....			120·84

Starling caps.	Number.
On top of cutwaters.....	6
Total No. of starling caps.....	6

Newel caps.	Number.
On tops of newels	4
Total No. of newel caps	4

Embanking.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Between straight portions of wings.	1	35·50	6·12	4·25	923·85
		Area.			
Do. curves of interior portions.	2	121·71		8·50	2,069·07
Do. do. exterior	4	90·10		9	3,240·36
Total solid feet embanking.....					6,232·78

Centering.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Segmental portion.....	4	14·47		11·50	803·60
Rectangular do.	4	10·00	2·18	11·50	1,002·80
Total solid feet centering.....					1,806·40

ABSTRACT.

Quantities.	Items.	Amount. Rs.	a.	p.
2,048	Solid feet excavation in hard moorum, at Rs. 1 per 100 solid feet	20	7	8
1,408	Solid feet filling in, of rubble stone and lime, at Rs. 16 per 100 solid feet	225	4	6
2,001	Solid feet superstructure, of coursed stone and chunam, at Rs. 20 per 100 solid feet.....	400	3	2
598	Solid feet arching, at Rs. 40 per 100.....	239	3	2
385	Do. backing, at Rs. 16 per 100	61	9	7
204	Do. concrete, at Rs. 15 per 100	30	9	7
1,087	Do. parapets, at Rs. 25 per 100	271	12	0
911	Superficial feet chunam plaster, at Rs. 5 per 100	45	8	10
911	Do. do. chunam pointing, at Rs. 4 per do.	36	7	0
121	Running feet string course, at Rs. 2 per foot ..	242	0	0
6	No. of starling caps, at Rs. 6 each	36	0	0
4	Do. of newel caps, at Rs. 4 each	16	0	0
6,233	Solid feet embanking of earth, at 8 annas per 100 solid feet	31	2	6
1,806	Solid feet centering, including wooden frames, at Rs. 16 per 100 cubic feet	288	15	4
	Total Rupees.....	1,945	3	4
	Add 5 per cent. for contingencies.....	97	4	2
	Add for extra Establishment:—			
1	Carcoon for 1½ months, at Rs. 20 per month.....	30	0	0
2	Mookadums for do. at Rs. 10 per do.	30	0	0
1	Chowkeedar for do. at Rs. 8 per do.	12	0	0
	Total amount for constructing one aqueduct..Rupees	2,114	7	6

(Signed) J. G. FIFE, Lieutenant Colonel, R.E.,
Superintending Engineer for Irrigation.

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V.—Miscellaneous Public Improvements.

Poona and Kirkee Water Supply.

ESTIMATE No. 2 of 1865-66.

ESTIMATE framed by Lieutenant Colonel Fife, *Superintending Engineer for Irrigation, of the Probable Cost of constructing three* 10 *feet span Aqueducts, on the Kirkee Canal line. Estimate framed agreeably to the instructions contained in Government Resolutions Nos.* $\frac{536 \text{ C. W.}}{1504 \text{ of } 1865,}$ *dated* 13*th July* 1865, *and* $\frac{213 \text{ M. W.}}{1733 \text{ of } 1865,}$ *dated* 10*th August* 1865.

Amount of Estimate, Rs. 2,550-1-9.

General Description.

The aqueduct to be of one 10 feet segmental arch. Rise $2\frac{1}{2}$ feet. Thickness of arching to be 1 foot. Abutments to be 2 feet thick. Wing walls to be partly straight and partly quadrants of $9\frac{1}{2}$ feet radius. Parapets to be $1\frac{3}{4}$ feet at bottom, and 9 inches at top. Waterway at bottom 8 feet, and at top 10 feet.

Construction.

Excavation for foundation in earth and moorum. Filling in of rubble and lime. Superstructure of coursed stone and lime. Parapets to be of burnt brick and lime. Archwork to be of stone slabs, chisel dressed for the facing only. Wing walls to be of coursed stone and lime.

MEASUREMENTS.

Excavation for foundation in moorum.	Number.	Length.	Breadth.	Depth.	SOLID FEET.
Abutments	2	13·50	4·50	6·75	820·12
Wing walls, left side, straight	2	8·50	3·25	2·75	151·93
Do. do. curved portion.	2	17·25	3·25	2·75	308·34
Do. right side	2	4·50	3·25	2·50	73·12
Do. do. circular portion.	2	3·75	3·25	3·00	73·12
Do. remaining do.	2	13·53	3·25	2·50	219·86
Newels at the ends of wings	4	·75	·75	3·50	7·87
Total solid feet excavation for foundation					1,654·36

Filling in foundation.					
Abutments	2	13·50	4·50	·75	91·12
Do.	2	12·50	3·50	·75	65·62
Wing walls, left side	2	8·50	3·25	2·75	151·93
Do. circular, do.	2	17·25	3·25	2·75	308·34
Do. right side	2	4·50	2·93	2·50	65·92
Do. circular, do.	2	3·75	2·62	3·00	58·95
Do. remaining do.	2	13·53	2·49	2·50	168·44
Newels at the ends of wings	4	·75	·75	3·50	7·87
Total solid feet filling in of stone and lime					918·19

Superstructure of coursed stone and lime.					
Abutments	2	11·50	2·50	2·50	143·75
Wing walls, straight, left	2	8·50	2·00	2·25	76·50
Do. circular	2	16·34	2·30	2·25	169·11
Do. right, straight	2	4·25	2·19	2·50	46·53
Do. circular	2	3·50	1·75	2·00	24·50
Do. 2nd portion	2	13·04	1·75	2·00	91·28
		Area			
Spandril walls	2	22·81		2·00	91·24
Newels at the ends of wings	4	·75	·75	6·75	15·18
Total solid feet superstructure					658·09

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Arch-work.					
Segmental ring in faced voussoirs..	1	Area. 12·06		11·50	138·69
Total solid feet of slabs with cut stone facing					138·69

Backing of rubble and lime.					
Over abutments.....	1	Area. 22·81		7·5	171·75
Total solid feet backing of rubble and lime					171·75

Concrete.					
For bed of water channel	1	15·00	9·00	0·50	67·50
Total solid feet concrete.....					67·50

Parapets of burnt brick and lime.					
Straight portions	2	29·00	1·25	2·50	181·25
Circular portions	4	15·90	1·25	2·50	198·75
Do. do.	4	15·46	·75	2·00	93·96
Straight portion, 2nd step.....	2	16·50	·75	2·00	49·50
Bottom portion of parapet	2	15·00	2·25	0·50	33·75
Total solid feet parapets of brick and lime..					557·21

String course.	Number.	Length.	Running Feet.
Round abutments	2	16·50	33·00
Over crown of arch	2	15·00	30·00
Total running feet string course			63·00

Skew backs.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Over abutments	2	11·50	Area. 2·00		46·00
Total solid feet skew backs					46·00

Chunam plaster.	Number.	Length.	Breadth.	Depth.	Superficial Feet.
Inside of parapets	2	29·00	2·50	....	145·00
Do. circular portions	4	15·90	2·50	....	159·00
Do. do.	4	15·46	2·00	....	123·68
Do. straight top portions	2	16·50	2·00	....	66·00
Superficial feet chunam plaster					493·68

Chunam pointing.					
Outside of parapets	2	29·00	2·50	....	145·00
Do. circular portions	4	15·90	2·50	....	159·00
Do. do.	4	15·46	2·00	....	123·68
Do. straight top portions	4	16·50	2·00	....	66·00
Total superficial feet chunam pointing					493·68

Newel caps.	Number.
On tops of newels	4
Total No. of newel caps	4

Embanking.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Between straight portions of wings, left side	1	14·00	6·50	3·00	273·00
		Area			
Do. interior, circular portions	2	96·96		8·00	1,551·36
Do. circular portions of wings, outside	4	51·00		7·00	1,428·00
Total solid feet embanking of earth					3,252·36

Centering.					
		Area			
Curved portion	1	17·47		11·50	200·90
Rectangular portion	1	5·00	1·75	11·50	100·62
Total solid feet centering					301·52

ABSTRACT.

Quantities.	Items.	Amount. Rs.	a.	p.
1,654	Solid feet excavation for foundation, at 1 Rupee per 100 solid feet	16	8	8
918	Solid feet filling in foundation with rubble stone and chunam, at Rs. 16 per 100 solid feet	146	14	1
658	Solid feet superstructure, of coursed stone and chunam, at Rs. 20 per 100 solid feet	131	9	7
139	Solid feet arching, of stone slabs, at Rs. 40 per 100 solid feet	55	9	7
	Carried forward....Rupees	350	9	11

ABSTRACT—*continued.*

Quantities.	Items.	Amount. Rs.	a.	p.
	Brought forward....Rupees	350	9	11
172	Solid feet backing of rubble and lime, at Rs. 16 per 100 solid feet.....	27	8	4
68	Solid feet concrete, at Rs. 15 per 100 solid feet	9	3	2
657·21	Do. parapets of burnt brick and lime at Rs. 25 per 100 solid feet	139	4	9
63	Running feet string course, at Rs. 2 per foot ..	126	0	0
46	Solid feet skew backs, at Rs. 30 per 100 solid feet	13	12	9
494	Superficial feet chunam plaster, at Rs. 5 per 100	24	11	2
494	Do. chunam pointing, at Rs. 4 per 100	19	12	2
4	No. of newel caps at Rs. 4 each.....	16	0	0
3,252·00	Solid feet of embanking, at 8 annas per 100 solid feet	16	4	1
302	Solid feet centering, including wooden plates, at Rs. 16 per 100 cubic feet	48	5	1
	Total.....Rupees	791	7	5
	Add 5 per cent. for contingencies	39	9	2
	Add for extra Establishment:—			
	1 Carkoon for half month at Rs. 20 a month..	10	0	0
	1 Mookadum for do. at 10 Rs. per do.	5	0	0
	1 Chowkedar for do. at 8 Rs. per do.	4	0	0
	Total of Rupees for constructing 1 aqueduct of 10 feet span	850	0	7
	For two more of similar spans	1,700	1	2
	Grand Total for three Aqueducts....Rs.	2,550	1	9

(Signed) J. G. FIFE, Lieut. Colonel, R.E.,
Superintending Engineer for Irrigation.

V.—Miscellaneous Public Improvements.

Poona and Kirkee Water Supply.

ESTIMATE No. 2 of 1865-66.

ESTIMATE framed by Lieutenant Colonel Fife, *Superintending Engineer for Irrigation, of the Probable Expense of constructing an Aqueduct of one* 15 *feet span, on the Kirkee Canal line. Estimate framed agreeably to the instructions contained in Government Resolution No.* $\frac{213 \text{ MW}}{1733 \text{ of } 1865,}$ *dated* 10*th August* 1865.

Amount of Estimate, Rs. 1,456-10-4.

General Description.

The aqueduct to consist of one arch of 15 feet span, 3·75 feet rise, and 1 foot 1 inch thick. The abutments to be 3 feet 9 inches thick, and 3 feet 3 inches high to springing of arch. The foundations carried down 2 feet 3 inches into the rock. The spandril walls to be 2 feet thick, and a layer of 6 inches of concrete to be laid over the top, to render the aqueduct water tight. The wing walls to be partly straight and partly curved, and 21·5 feet in length on the south side, and 17·5 feet on the north side. The parapet walls to be 5 feet high over wing walls, 1 foot 9 inches thick at bottom, and 9 inches thick at top. Over the arch, and half way over each abutment, the parapet wall to be 3 feet high, 1 foot 9 inches thick at bottom, and 9 inches at top.

Construction.

Excavation for foundation in hard moorum. Filling in of rubble stone and lime. Superstructure of coursed rubble masonry. Parapets of well burnt bricks and lime, plastered inside and pointed outside. Arching of stone slabs with voussoirs chisel dressed. Newels, starling caps, and string course to be of 2nd sort cutstone.

MEASUREMENTS.

Excavation for foundation in hard moorum.	Number.	Length.	Breadth.	Depth.	SOLID FEET.
Abutments	2	13·50	5·75	7·00	1,086·75
Wing walls, left hand side	2	23·28	3·50	3·00	488·88
Wing walls, right hand side	2	6·00	3·50	3·00	126·00
Do. do.	2	13·28	3·00	2·50	199·20
Newels	4	·75	·75	3·25	7·31
Total solid feet of excavation for foundation in hard moorum					1,908·14
Filling in foundation.					
Abutments	2	13·00	5·25	1·50	204·75
Wing walls, left hand side	2	24·25	3·12	3·00	453·96
Wing walls, right hand side	2	7·00	3·00	4·50	189·00
Do. do.	2	13·28	2·75	2·50	182·60
Newels	4	·75	·75	3·25	7·31
Total solid feet of filling in foundation					1,037·62
Superstructure.					
Abutments	2	11·50	3·75	4·50	388·12
Wing walls, left hand side	2	27·28	2·37	3·00	987·92
Wing walls, right hand side	2	20·28	2·25	1·50	136·89
Newels	4	·75	·75	6·75	15·28
		Area			
Spandril walls	4	35·70		2·00	285·60
Portions of wall over abutments	2	11·50	3·00	5·30	365·70
Total solid feet of superstructure of coursed rubble masonry					2,179·41
Arch-work.					
Arching, including rings of voussoirs, cutstone, 2nd sort	1	11·50	17·66	1·10	223·39
Total solid feet of arching					223·39

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Backing.					
Backing to arch	2	Area. 35·70		7·50	535·50
Total solid feet of backing of uncoursed masonry					535·50
Parapets.					
Bottom portion	2	22·50	2·00	0·50	45·00
1st portion	2	67·00	1·25	2·50	418·75
2nd portion	2	44·50	·75	2·50	166·87
Total solid feet of parapets, of well burnt bricks and lime					630·62
Concrete.					
Concrete	1	22·5	7·5	·5	84·37
Total solid feet of concrete					84·37
Skew backs.					
Skew backs	2	11·50	Area. ·75		17·25
Total solid feet of skew backs					17·25

	Number.	Length.	Breadth.	Superficial Feet.
Chunam plastering.				
Plastering inside, 1st portion	2	67·00	3·00	402·00
Ditto 2nd portion	2	44·50	2·00	178·00
Total superficial feet of chunam plastering				580·00

Chunam pointing.	Number.	Length.	Breadth.	Depth.	Superficial Feet.
Chunam pointing, outside of parapets, same as plastering inside..	..	....	....	....	580·00
Total superficial feet of chunam pointing					580·00

Centering.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Centering	1	15·00	11·50	7·00	1,207·50
Total solid feet of centering					1,207·50

Embanking.					
Between wing walls	1	12·50	5·50	2·50	171·87
Do. do.	1	6·75	4·00	1·75	47·25
Do. do.	1	16·75	5·00	3·00	251·25
Do. do.	1	10·25	5·50	2·75	155·03
		Area.			
Exterior	4	78·19		8·00	2,502·08
Total solid feet of embankment ..					3,127·48

Newel caps.	Number.
Newel caps	4
Total number of newel caps	4

String course.	Number.	Length.	Running Feet.
String course round abutments.....	2	19	38
Total number of running feet of string course....			38

ABSTRACT.

Quantities.	Items.	Amount.		
		Rs.	a.	p.
1,908·14	Solid feet of excavation for foundation in hard moorum, at 1 Rupee per 100 solid feet	19	1	3
1,037·62	Solid feet filling in of uncoursed rubble masonry, at Rs. 16 per 100 solid feet.....	166	0	2
2,179·41	Solid feet of superstructure, of coursed rubble masonry, at Rs. 20 per 100 solid feet.....	435	14	0
223·39	Solid feet of arching including voussoirs, 2nd sort cutstone, at Rupees 40 per 100 solid feet.	89	5	8
535·50	Solid feet of backing of uncoursed rubble masonry, at Rs. 16 per 100 solid feet.....	85	10	10
630·62	Solid feet of parapet walls, of burnt brick and lime, at Rupees 25 per 100 solid feet	157	10	5
84·37	Solid feet of concrete for bedding, at Rs. 15 per 100 solid feet	12	10	5
17·25	Solid feet of skew backs at Rs. 30 per 100 solid feet	5	2	10
4	Number of newel caps, at Rupees 4 each	16	0	0
38	Running feet of string course, at Rupees 2 per foot	76	0	0
580	Superficial feet of chunam plastering, at Rupees 5 per 100 superficial feet.....	29	0	0
580	Superficial feet of pointing outside, at Rs. 4 per 100 superficial feet	23	3	2
1,207·50	Solid feet of centering, of stone and mud, including wooden rings, at 16 Rupees per 100 solid feet	193	1	11
3,127·48	Solid feet of embankment, at Annas 8 per 100 solid feet	15	10	2
	Total.....	1,324	6	10
	Add 5 per cent. for contingencies	66	3	6
	Add for extra Establishment:—			
	1 Carcoon for 2 months, at Rupees 15 per month	30	0	0
	1 Moocadum for do. at Rupees 10 per month..	20	0	0
	1 Chowkeedar for do. at Rupees 8 per month..	16	0	0
Grand Total of Rupees for constructing an aqueduct on the Kirkee Canal line.....		1,456	10	4

(Signed) J. G. FIFE, Lieutenant Colonel, R. E.,
Superintending Engineer for Irrigation.

V.—Miscellaneous Public Improvements.

Poona and Kirkee Water Supply.

ESTIMATE No. 2 of 1865-66.

ESTIMATE framed by Lieut. Colonel FIFE, *Superintending Engineer for Irrigation, of the Probable Cost of constructing* 12 *five feet Culverts on the Kirkee Canal. Estimate framed agreeably to the instructions contained in Government Resolution No.* $\frac{213 \text{ M W}}{1733 \text{ of } 1865}$, *dated* 10*th August* 1865.

Amount of Estimate, Rs. 8,545-4-0.

GENERAL DESCRIPTION.

The culvert is to be of 5 feet span, with a rise of the arch of 1·25 feet. Abutments to be 2 feet thick. Wing walls to be partly straight and partly curved, 2 feet thick at top, with a batter of $\frac{1}{4}$th of the height in rear. Parapets to be 1·75 feet at bottom and ·75 foot at top. Thickness of arching to be 1 foot.

CONSTRUCTION.

Excavation for foundation in moorum and earth. Filling in of rubble and lime. Superstructure of coursed stone and lime. Concrete bedding for the bottom of the channel. Parapets to be of well burnt brick and lime. Archwork to be of stone slabs with 2nd sort cutstone voussoirs for facing. Newel caps and string course to be of 2nd sort cutstone; and embankments of earth in 1 foot layers, well rammed.

MEASUREMENTS.

Excavation for foundation in moorum.	Number.	Length.	Breadth.	Depth.	SOLID FEET.
Abutments, left	1	12	2·50	1·75	52·50
Do. right	1	12	2·50	2·00	60·00
Wingwalls, right, straight portion	2	5·75	3·50	2·50	100·62
Do. do. curved do.	2	13·35	3·00	3.00	240·00
Do. straight, left	2	9·75	3·25	2·00	126·75
Do. curved do.	2	13·55	3·25	3·00	264·22
Newels, right	2	·75	·75	4·50	5·06
Do. left	2	·75	·75	3·50	3·93
Total solid feet excavation for foundation					853·08
Filling in of rubble stone and lime.					
Abutments	2	12·00	2·50	1·00	60·00
Wingwalls, straight, left	2	9·75	3·25	2·00	126·75
Do. curved	2	13·55	3·00	3·00	243·90
Do. right, straight	2	5·75	3·25	2·50	93·43
Do. do. curved	2	3·35	2·95	3·00	236·29
Newels at the ends of wings	2	·75	·75	4·50	5·06
Do. do.	2	·75	·75	3·50	3·93
Total solid feet filling in for foundation					769·36
Superstructure of coursed stone and lime.					
Abutments	2	11·50	2·00	3·00	138·00
		Area.			
Spandril walls	2	6·77		2·00	27·00
Wing walls, left side, straight	2	10·00	2·75	4·50	247·50
Do. do. curved	2	13·15	2·75	3·50	253·13
Do. right	2	6·00	2·75	3·50	115·50
Do. do. curved	2	12·96	2·50	1·00	64·80
Newels	2	·75	·75	3·50	3·93
Do.	2	·75	·75	5·50	6·18
Total solid feet superstructure					856·04

Arch-work.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Ring	1	Area. 9·13		11·50	104·90
Total solid feet slab stone arching set in chunam					104·90

Backing.				
Over abutments	1	Area 6·77	7·50	50·77
Total solid feet backing				50·77

String course.	Number.	Length.	Breadth.	Depth.	Running Feet.
Round abutments	2	15·50	..	..	31·00
Total running feet string course					31·00

Concrete.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Bottom of channel	1	9	8	0·5	36·00
Total solid feet concrete bedding					36·00

Parapets.					
Bottom portion	2	9·00	2·25	0·50	20·25
Both sides of channel, 1st portion ..	2	54·84	1·25	2·50	342·75
Do. do. 2nd do. ..	2	45·84	·75	1·50	103·14
Total solid feet brick and chunam parapets					466·14

Chunam plaster.	Number.	Length.	Breadth.	Superficial Feet.
Outside of parapets, 1st portion	2	54·84	2·50	274·00
Do. do. 2nd do.	2	45·84	2·00	183·36
Total superficial feet chunam plaster....				457·36

Chunam pointing.				
Outside of parapets, 1st portion	2	54·84	2·50	274·00
Do. do. 2nd do.	2	45·84	2·00	183·36
Total superficial feet chunam pointing				457·36

Skew backs.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Over abutments.....	2	11·50	1·60	·75	27·60
Total solid feet skew backs.....					27·60

Newel caps.	Number.
On tops of newels	4
Total No. of newel caps....	4

Embanking.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Between straight portions.....	1	16	7·00	3·50	392·00
		Area.			
Do. curved, interior	2	79·47		5·50	874·17
Do. do. exterior	4	50·47		6·50	1,304·32
Total solid feet embanking....					2,580·99

Centering.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Curved portions	1	4·36		11·50	50·14
Rectangular do.	1	5·00	2·66	11·50	153·00
				Total solid feet centering	203·14

ABSTRACT.

Quantities.	Items.	Amount. Rs.	a.	p.
853	Solid feet excavating for foundation, at Rs. 1 per 100 solid feet	8	8	5
769	Solid feet filling in do., at Rs. 16 per 100 solid feet	123	0	8
856	Do. superstructure, at Rs. 20 per do.	171	3	2
105	Do. arch-work, at Rs. 40 per do.	42	0	0
57	Do. backing, at Rs. 16 per do.	8	2	6
31	Running feet string course, at Rs. 2 per foot ..	62	0	0
36	Solid feet concrete, at Rs. 15 per 100 solid feet	5	6	5
466	Do. parapets, at Rs. 25 per do.	116	8	0
457	Superficial feet chunam plaster, at Rs. 5 per 100 superficial feet	22	13	7
457	Superficial feet chunam pointing, at Rs. 4 per do.	18	4	5
28	Solid feet skewbacks, at Rs. 30 per 100	8	6	4
4	No. of newel caps, at Rs. 4 each	16	0	0
2,581	Solid feet embanking, at 8 annas per 100 feet..	12	14	4
203	Do. centering, including wooden work, at Rs. 16 per 100 cubic feet	32	7	8
		647	11	6
	Add contingencies at 5 per cent.....	32	6	2
	Total....Rupees	680	1	8
	Extra Establishment:—			
	1 Carkoon for 1 month at Rs. 15 per month	15	0	0
	1 Mookadum for do. at Rs. 9 per do.	9	0	0
	1 Chowkedar for do. at Rs. 8 per do.	8	0	0
	Grand Total Rupees for constructing 5 feet culvert on the Kirkee canal	712	1	8
	Add for 11 culverts more	7,833	2	4
	Total....Rupees	8,545	4	0

(Signed) J. G. FIFE, Lieut. Colonel, R.E.,
Superintending Engineer for Irrigation.

V.—Miscellaneous Public Improvements.

Poona and Kirkee Water Supply.

ESTIMATE No. 2 of 1865-66.

ESTIMATE framed by Lieut. Colonel FIFE, *Superintending Engineer for Irrigation, of the Probable Cost of constructing five Slab Drains, of 2 openings, on the Kirkee Canal line. Estimate framed agreeably to the instructions contained in Government Resolution No.* $\frac{213 \text{ M W}}{1733 \text{ of } 1865,}$ *dated 10th August* 1865.

Amount of Estimate, Rs. 1,240-8-4.

GENERAL DESCRIPTION.

The slab drains to be of two openings 3 feet by 3 feet. Abutments to be 2 feet thick. Piers to be 1½ feet. Wing walls straight, of 9 inches uniform thickness at top and end, and 1½ feet at commencement, with a batter of 9 inches in the whole height of 8½ feet. The waterway at bottom to be 8 feet and at top 10 feet. Parapet walls to be 1·75 feet thick at bottom, and 9 inches at top.

CONSTRUCTION.

Excavation for foundation in moorum. Filling in foundation of rubble stone and chunam. Superstructure, including wing walls and cutwaters, of hammer dressed stone and chunam. Slab stone covering 9 inches thick; to receive a 9 inches coat of concrete bedding for the bottom of the channel. Parapets to be of well burnt brick and lime, plastered inside, and pointed outside.

MEASUREMENTS.

Excavation for foundation in moorum.	Number.	Length.	Breadth.	Depth.	SOLID FEET.
Abutments	2	12·00	2·50	2·00	120·00
Piers	1	14·50	2·00	2·00	58·00
Wing walls	4	9·00	2·75	2·25	222·75
Newels at the end of wings	4	1·50	1·50	2·50	22·50
Total solid feet excavation in moorum					423·25

Filling in of rubble and chunam.					
Abutments	2	12·00	2·50	2·00	120·00
Piers	1	11·50	2·00	2·00	46·00
		Area			
Cutwaters	2	1·90		2·00	7·60
Wing walls, 1st portion	4	4·50	1·62	2·00	58·32
Do. 2nd do.	4	4·50	1·12	2·00	40·32
Newels at the end of wings	4	1·50	1·50	1·00	9·00
Total cubic feet filling in of rubble and lime					281·24

Superstructure, of coursed stone and lime.					
Abutments	2	11·50	2·00	4·50	227·00
Piers	1	11·50	1·50	4·50	17·25
		Area			
Cutwaters	2	1·36		3·00	8·16
Wing walls, 1st portion	4	4·50	1·07	5·75	110·74
Do. 2nd do.	4	4·50	0·95	4·75	81·22
Newels at the ends of wings	4	1·00	1·00	3·00	12·00
Total solid feet superstructure of rubble and lime					456·37

Covering.	Number.	Length.	Breadth.	Depth.	Superficial Feet.
Slab stones	2	11·50	3·00	....	69·00
Superficial feet covering of slab stones.....					69·00

Concrete.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Bedding of channel	1	11·50	8·00	·75	69·00
Total solid feet concrete bedding for channel.....					69·00

Parapets.					
Both sides of channel	2	11·50	1·25	4·00	115·00
Total solid feet parapets of burnt brick and lime....					115·00

Chunam plaster.	Number.	Length.	Breadth.	Depth.	Superficial Feet.
Inside of parapets.....	2	11·50	4·00	..	92·00
Total superficial feet chunam plaster.....					92·00

Chunam pointing.					
Outside of parapets	2	11·50	4·00	..	92·00
Total superficial feet chunam pointing.....					92·00

Newel caps.	Number.
On top of newels	4
Total number of newel caps.....	4

ABSTRACT.

Quantities.	Items.	Amount. Rs.	a.	p.
423	Solid feet excavation in moorum at Rs. 1 per 100 feet	4	3	9
281	Solid feet filling in, with stone and chunam at Rs. 16 per do.....	44	15	4
456	Solid feet superstructure, of hammer dressed stone and chunam, at Rs. 18 per 100	82	1	3
69	Square feet slabstone covering, at As. 8 per foot	34	8	0
69	Solid feet concrete bedding, at Rs. 15 per 100 solid feet	10	5	7
115	Solid feet parapets, of burnt brick and chunam, at Rs. 25 per 100 solid feet	28	12	0
92	Square feet chunam plaster, at 5 Rs. per 100 feet	4	9	7
92	Do. chunam pointing, at 4 Rs. per 100 feet	3	10	10
4	Number of newel caps, at Rs. 4 each	16	0	0
	Total....Rupees	229	2	4
	Add contingencies at 5 per cent.....	11	7	4
	Extra Establishment:—			
	1 Carkoon for 8 days at Rs. 12 per month ..	3	0	0
	1 Mookadum do. at Rs. 8 do. ..	2	0	0
	1 Storekeeper do. at Rs. 10 do. ..	2	8	0
	Total....Rupees	248	1	8
	Add for 4 more	992	6	8
	Grand Total Rupees for five slab drains of 2 three feet openings	1,240	8	4

(Signed) J. G. FIFE, Lieut. Colonel, R. E.,
Superintending Engineer for Irrigation.

Poona and Kirkee Water Supply.

ESTIMATE No. 2 of 1865-66.

ESTIMATE framed by Lieutenant-Colonel Fife, *Superintending Engineer for Irrigation, of the Probable Cost of constructing ten Syphon Drains on the Kirkee Canal line. Estimate framed agreeably to the instructions contained in Government Resolution No.* $\frac{213 \text{ M W}}{1733 \text{ of } 1865}$, *dated 10th August* 1865.

Amount of Estimate, Rs. 1,093-14-10.

General Description.

The syphon drains will be 3 feet by 1½ feet, of one opening only. Abutments will be $11\frac{1}{2} \times 1\frac{1}{2} \times 1\frac{1}{2}$ feet. Wing wall 8 feet by 0·75 foot, the mean height being 3·75 feet. On the down stream side the bed of the stream will be excavated to bring it to a level with the bottom of abutments. The up stream sides to be excavated 10 feet long, 6 feet broad, and 2 feet deep.

Construction.

Excavating foundation in earth and moorum. Filling in of rubble stone and chunam. Superstructure of hammer dressed stone and chunam. Covering of 9 inches thick stone slabs, to receive a coating of 9 inches of concrete to form the bed of the channel. Coping of well burnt brick and chunam, plastered inside, and pointed outside.

MEASUREMENTS.

Excavation for foundation and for channel.	Number.	Length.	Breadth.	Depth.	SOLID FEET.
Abutments	2	12·00	2·00	1·50	72·00
Wing walls	2	7·50	1·12	1·50	25·20
Newels at the ends of wings	2	1·25	1·25	1·50	4·68
Bed to form syphon channel, 1st portion	1	10·00	6·00	1	60·00
2nd do. do.	1	11·50	6·50	1·75	130·81
3rd do. do.	1	40·00	6·00	0·75	180·00
Total solid feet excavation in moorum and earth					472·69
Filling in, of rubble and lime.					
Abutments	2	12·00	2·00	1·50	72·00
Wing walls	2	7·50	1·12	1·50	25·20
Newels at the ends of wings	2	1·25	1·25	1·50	4·68
Total solid feet filling in of rubble and lime					101·88
Superstructure, of hammer-dressed stone and lime.					
Abutments	2	11·50	1·50	2·00	69·00
Wing walls	2	8·00	0·94	3·25	48·88
Newels at the ends of wings	4	·75	·75	2·00	4·50
Total solid feet superstructure, of hammer dressed stone and lime					122·38

Covering.	Number.	Length.	Breadth.	Depth.	Square Feet.
Slab stones	1	11·50	4·00	....	46·00
Total square feet covering of slab stones....					46·00

Concrete.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Bedding for channel	1	6·00	8·00	·75	36·00
Total cubic feet concrete bedding for channel					36·00

Parapets of burnt brick and chunam.					
Both sides of channel.....	2	6·00	1·25	3·00	45·00
Total solid feet parapets of brick and lime....					45·00

Newel caps.	Number.
On top of newels.....	4
Total No. of newel caps	4

ABSTRACT.

Quantities.	Items.	Amount. Rs. a. p.
473	Solid feet excavation in earth and moorum, at Rs. 1 per 100 solid feet	4 11 8
102	Solid feet filling in of rubble stone and chunam, at Rs. 16 per 100 solid feet	16 5 1
122	Solid feet superstructure of hammer dressed stone and lime, at Rs. 18 per 100	21 9 4
46	Superficial feet covering, of slab stones set in mortar, at 8 annas per foot.....	23 0 0
36	Solid feet concrete, at Rs. 15 per 100	5 6 5
45	Superficial feet parapets of burnt brick and lime, at Rs. 25 per 100 solid feet	11 4 0
4	Newel caps at Rs. 4 each	16 0 0
	Total ....Rupees	98 4 6
	Add contingencies at 5 per cent.	4 14 7
		103 3 1
	Add for 9 more	928 11 9
	Total....Rupees	1,031 14 10
	Extra Establishment:—	
	1 Carkoon for 2 months at Rs. 15 per mensem	30 0 0
	1 Mookadum for 2 months at Rs. 8 per mensem....	16 0 0
	1 Chowkedar for 2 months at Rs. 8 per mensem....	16 0 0
	Grand Total Rupees for 10 syphon drains on the Kirkee Canal line.....	1,093 14 10

(Signed) J. G. FIFE, Lieut. Colonel, R.E.,
Superintending Engineer for Irrigation.

V.—Miscellaneous Public Improvements.

Poona and Kirkee Water Supply.

ESTIMATE No. 2 of 1865-66.

ESTIMATE framed by Lieutenant Colonel Fife, *Superintending Engineer for Irrigation, of the Probable Expense of constructing an Over-bridge crossing on the Kirkee Duct, for the old Poona and Bombay Road. Estimate framed agreeably to instructions contained in Government Resolution No.* $\frac{218 \text{ M W}}{1738 \text{ of } 1865}$, *dated 10th August* 1865.

Amount of Estimate, Rs. 949-3-3.

General Description.

The bridge is to consist of one 9 feet segmental arch, 1 foot 6 inches rise; one foot thickness of arch ring; 2 feet 6 inches thickness of abutments. The roadway to be 28 feet in the clear. Parapets to be 1 foot thick. Wing walls to be 1 foot thick at top, and to have exterior batter of one foot in the whole height of 3 feet 6 inches.

Construction.

Excavation for foundation in hard moorum. Filling in of rubble stone and lime. Superstructure of dressed stone and lime. Wing walls to be of coursed stone and lime. Parapets to be of 2nd sort cutstone. Arching of stone slabs set in lime, with 2nd sort cutstone facing voussoirs. String course and blocking course of 2nd sort cutstone. Coping to wing walls of dressed stones.

MEASUREMENTS.

	Number.	Length.	Breadth.	Depth.	SOLID FEET.
Excavation for foundation and duct.					
Excavation of the whole, from abutment to abutment	1	31·00	15	8·50	3,952·50
Wing walls, 1st portion	4	1·50	2	5·50	66·00
Do. 2nd do.	4	1·75	2	4·50	27·00
Do. 3rd do.	4	1·75	2	3·50	49·00
Do.	1	8	30	1·50	360·00
Total solid feet excavation					4,454·50
Filling in of rubble stone and lime.					
Abutments, 1st portion	2	31·00	3·50	·75	162·75
Wing walls, 1st do.	4	2·00	1·70	1·00	13·60
Do. 2nd do.	4	2·75	1·70	1·00	18·70
Do. 3rd do.	4	3·25	1·50	1·25	24·37
Total solid feet filling in of rubble stone and lime....					219·42
Superstructure.					
Abutments	2	30·00	2 50	3·25.	487·50
Wing walls	4	5·25	1·85	1·75	67·98
		Area			
Spandril walls	2	16·11		2·00	64·44
Total solid feet superstructure of dressed stone and lime..					619·92

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Arch-work.					
Ring, including cutstone facing voussoirs	1	Area. 9·22		30·00	276·60
Total solid feet arch-work					276·60
Backing.					
Over abutments	1	Area. 10·65		26·00	276·90
Solid feet backing of rubble and lime					276·90
Skew backs.					
Over abutments	2	30·00	2·75	·82	86·10
Total solid feet skew backs					86·10
Blocking course, including cornice.					
Over crown of arch	2	14	2	1	56·00
Total solid feet blocking course					56·00

	Number.	Length.	Breadth.	Depth.	Superficial Feet.
Coping to wing walls.					
On both sides	4	5·25	1·25	..	26·25
Total superficial feet coping to wing walls					26·25

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Filling in, of hand packed stones.					
Over abutments.....	1	Area. 5·46		26·00	141·96
Total solid feet filling.....					141·96

Moorum.					
Over the whole of the bridge	1	14	27	1	378·00
Total solid feet moorum filling.....					378·00

Metalling.					
Over bridge	1	Area. 17·50		14	245·00
Total solid feet metalling, including watering and rolling..					245·00

Parapet walls.					
Both sides	2	14	1	2·50	70·00
Total solid feet parapets.....					70·00

	Number.	Length.	Breadth.	Depth.	Superficial Feet.
Cutstone work.					
Parapet wall, including coping....	2	14	8	..	224·00
Total superficial feet cutstone work....					224·00

ABSTRACT.

Quantities.	Items.	Amount Rs.	a.	p.
4,455	Solid feet excavation in hard moorum, at Rs. 1 per 100 solid feet	44	8	9
219	Solid feet filling in of rubble stone and lime, at Rs. 16 per 100 solid feet	35	0	7
620	Solid feet superstructure of dressed stone and lime, at Rs. 30 per 100 solid feet	186	0	0
277	Solid feet arch work, at Rs. 70 per 100 solid feet	193	14	5
277	Solid feet backing, at Rs. 16 per do.	44	5	1
86	Solid feet skew backs, at Rs. 30 per do.	25	12	9
56	Solid feet blocking course, at Rs. 1 per foot	56	0	0
26·25	Superficial feet coping to wing walls, at Rs. 1 per foot	26	4	0
142	Solid feet filling in, of hand packed stones, at Rs. 8 per 100 solid feet	11	5	9
378	Solid feet moorum, at Rs. 1½ per 100 solid feet.	5	10	9
245	Solid feet metalling, at Rs. 8 per do	19	9	7
70	Solid feet parapet walls, at Rs. 20 per do	14	0	0
224	Superficial feet cutstone work, at 8 As. per foot.	112	0	0
	Total....Rupees	774	7	8
	Add contingencies at 5 per cent.	38	11	7
	Extra Establishment :—			
1	Carkoon for 4 months, at Rs. 15 per month.	60	0	0
1	Mookadum for do., at Rs. 9 per do.	36	0	0
1	Storekeeper for do., at Rs. 10 per do.	40	0	0
	Grand Total for an Over-bridge crossing on the old Bombay and Poona road for the Kirkee Canal	949	3	3

(Signed) J. G. FIFE, Lieut.-Colonel, R.E.,
Superintending Engineer for Irrigation.

V.—Miscellaneous Public Improvements.

Poona and Kirkee Water Supply.

ESTIMATE No. 2 OF 1865-66.

ESTIMATE framed by Lieutenant-Colonel FIFE, *Superintending Engineer for Irrigation, of the Probable Cost of excavating a Duct on the right bank of the River Moota, for the supply of water at Poona and Poona Cantonment. Estimate framed agreeably to Government Resolution No.* $\frac{213 \text{ M.W.}}{1733 \text{ of } 1865,}$ *dated* 10*th August* 1865.

Amount of Estimate, Rupees 42,901-1-9.

GENERAL DESCRIPTION.

The duct on the Poona side will have a slope of 6 inches per mile, a bottom width of 10 feet, depth 3 feet, velocity of the current 1·2023 feet, and theoretical discharge 52·30 cubic feet per second. This duct will supply 13 cubic feet per second for the irrigation of 2,000 acres; 2·75 cubic feet per second, or 1,500,000 gallons per day for the cantonment of Poona; and the same number of gallons per day for the city of Poona. The duct will be of uniform size, that a week's supply for the city and cantonment of Poona may be carried in a few hours to the expense reservoir, in order that the water may not sustain injury from passing in a slender stream along an open channel. The length of the duct will be 11 miles and 1,436 yards. At that distance from the headworks, settling and expense reservoirs, each capable of holding a week's supply, are provided.

MEASUREMENTS.

Excavation for Duct.	Number.	Length.	Area.	Solid feet cutting in earth.	Solid feet cutting in moorum.	Solid feet cutting in rock.
Mile No. 1, Section Sheet No. 1.						
Earth	1	5,497	53·37	293,374	.....	.....
Moorum....	1	4,716	53·37	.....	251,492	.....
Rock	..	....	....	.....	.....	.....
Miles 2 and 3, Section Sheet 2.						
Earth	1	5,064	43·50	220,284	.....	.....
Moorum....	1	4,222	43·50	.....	183,657	.....
Rock	..	....	....	.....	.....	.....
Miles 4 and 5, Section Sheet No. 3.			nearly			
Earth	1	5,866	40·00	234,640	.....	.....
Moorum....	1	4,504	40·00	.....	180,160	.....
Rock	..	....	....	.....	.....	.....
Miles 6, 7, and 8, Sheet No. 4.						
Earth	1	1,074	40·00	42,960	.....	.....
Moorum....	1	7,107	40·00	.....	284,280	.....
Rock	1	2,504	40·00	.....	.....	100,160
Miles No. 8, 9, & 10, Sheet No. 5.						
Earth	1	1,514	43·50	65,859	.....	.....
		4,719	115·50	545,044	.....	.....
Moorum....	1	4,268	43·50	.....	185,658	.....
		2,996	176·00	.....	527,296	.....
Rock	..	....	....	.....	.....	.....
Miles 10, 11, and 12, Sheet No. 6.						
Earth	1	438	43·50	18,973	.....	.....
Moorum....	1	7,899	58·63	.....	463,118	.....
Rock	..	....	....	.....	.....	.....
Total solid feet....				1,421,134	2,075,661	100,160

Planting hedge.	Miles.	Total Miles.
Planting prickly pear hedge on both sides of the canal near Poona	2×2	4

Retaining Wall.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Excavation for foundation in moorum.					
Excavation for foundation in moorum	1	1,181	5·50	1	6,495·50
Total solid feet of excavation in moorum					6,495·50
Filling in foundation.					
Filling in foundation, same as excavation, with uncoursed rubble masonry	..	....	....	....	6,495·50
Total filling in of foundation					6,495·50
Superstructure.					
Superstructure	1	1,181	2·75	6	19,486·50
Total solid feet of superstructure					19,486·50
Earth work.					
Embankment	1	1,181	9·00	3·00	31,887·00
Total solid feet of earthen embankment					31,887·00

ABSTRACT.

Quantities.	Items.	Amount. Rs. a. p.
1,421,134	Solid feet cutting in earth, at 8 Annas per 100 solid feet	7,105 10 8
2,075,661	Solid feet of cutting in moorum, at 1 Rupee per 100 solid feet	20,756 9 9
100,160	Solid feet of cutting in rock, at Rupees 4 per 100 solid feet	4,006 6 4
4	Miles of hedging, at Rupees 500 per mile	2,000 0 0
6,495·5	Solid feet of excavation for foundation in moorum, at 1 Rupee per 100 solid feet	64 15 3
6,495·5	Solid feet filling in foundation of uncoursed masonry, at Rupees 16 per 100 solid feet	1,039 4 5
19,486·5	Solid feet of superstructure, at Rupees 20 per 100 solid feet	3,897 4 9
31,887	Solid feet of embanking, at 8 Annas per 100 solid feet	159 6 11
	Total.... Rupees	39,029 10 1
	Add 5 per cent. for contingencies....	1,951 7 8
	Extra Establishment :—	
	4 Carcoons for 2 years, at Rupees 20 per month ..	960 0 0
	8 Moocadums for do. at Rs. 10 do.....	960 0 0
	Grand Total of Rupees for constructing a Duct 11 miles and 1,436 yards long, and a retaining wall	42,901 1 9

(Signed) J. G. FIFE, Lieut.-Colonel, R.E.,
Superintending Engineer for Irrigation.

V.—Miscellaneous Public Improvements.

Poona and Kirkee Water Supply.

ESTIMATE No. 2 of 1865-66.

ESTIMATE framed by Lieutenant-Colonel Fife, *Superintending Engineer for Irrigation, of the Probable Cost of constructing Aqueducts, Barrel Drains, and Road Bridges on the Poona Duct. Estimate framed agreeably with instructions contained in Government Resolution No.* $\frac{536 \text{ C. W.}}{1504 \text{ of } 1865}$, *dated 13th July* 1865, *and Government Resolution No.* $\frac{213 \text{ M. W.}}{1733 \text{ of } 1865}$, *dated 10th August* 1865.

General Description.

On the line of the Poona duct, there will be in all thirteen aqueducts, viz. one of 3 arches, the centre 30 feet span, and the side arches each 20 feet span; two of five arches of 15 feet span; one of three arches of 30 feet span; one of three arches of 10 feet span; one of one arch of 30 feet span; and 7 of one arch of 15 feet span. There will be four barrel drains of one opening of 3 feet diameter, and three of two openings of 3 feet diameter.

There are five road bridges, each of 15 feet span; these are all over-bridges. The rise of the arches, the dimensions of the various parts of the bridges, and number of running feet of waterway, in each case, will be seen by reference to the Table, page 137.

Four of the aqueducts, viz. Nos. 4, 6, 12, and 13, each of which are of one arch of 15 feet span, are unprovided with abut-

ments ; the ends of the archrings abutting on the rock, which is of a sufficiently solid nature to render the building of regular abutments unnecessary. No. 3 aqueduct, of 3 arches of 10 feet span, has been provided with inverts, no rock being found in the nulla except at a considerable depth.

Construction.

The foundation in every case to be of uncoursed rubble masonry. The superstructure of aqueducts and drains of common coursed rubble in chunam. The parapets to be $1\frac{1}{2}$ feet thick at top, and 2 feet at bottom ; copings of dressed stone. The parapets of aqueducts to be 2 feet lower in the centre than at wings. The breadth of channel to be 15 feet at bottom, and $15\frac{1}{2}$ feet at water level. The wing walls to be 1 foot 6 inches thick at top, and to have a mean thickness of $\frac{1}{4}$th of height. The superstructure and parapets of road bridges to be of good coursed rubble in chuman, and copings of best close jointed work. The barrel drains to be of well burnt brick and chunam, the thickness of barrel being one foot. The embankments to be formed in layers of one foot in thickness, sloping inwards from both faces towards the centre. The side slopes to be $1\frac{1}{2}$ to 1, and the whole exposed surface covered with hard soil.

TABLE showing Dimensions of Aqueducts, Road Bridges, and Culverts on the Poona Duct.

Description of the works.	Span.	Number of Waterways.	Thickness of Abutments.	Thickness of Piers.	Thickness of Arch rings.	Rise, or versed sine.	Area of the transverse channel.	Discharge per Second.	Amount.			Remarks.
									Rs.	a.	p.	
Aqueduct No. 1	30	1	7	..	2	10	45	52	7,779	7	2	
Do. „ 2	15	5	4	3	15	4	45	52	5,100	5	10	
Do. „ 3	10	3	3	2	1	2	45	52	4,540	2	1	
Do. „ 4	15	1	..	..	1½	2½	45	52	1,010	0	0	
Do. „ 5	15	5	4	2½	1½	5	45	52	14,360	0	0	
Do. „ 6	15	1	..	..	1	2½	45	52	1,010	0	0	
Do. „ 7	15	1	4	..	1½	4	45	52	3,832	8	8	
Do. „ 8	15	1	4	..	1½	4	45	52	3,832	8	8	
Do. „ 9	15	1	4	..	1½	2½	45	52	1,489	11	0	
Do. „ 10	30	3	7½	4·5	2	5	45	52	9,599	2	9	
Do. „ 11	1 of 30′ 2 of 20′	3	5	3·75	1·5	5	45	52	10,417	0	0	
Do. „ 12	15	1	..	..	1½	2½	45	52	1,010	0	0	
Do. „ 13	15	1	..	..	1½	2½	45	52	1,010	0	0	
Bridge No. 1	15	1	4	..	1½	3	45	52	1,689	0	0	
Do. „ 2	15	1	4	..	1½	3	45	52	1,689	0	0	
Do. „ 3	15	1	4	..	1½	3	45	52	2,252	0	0	
Do. „ 4	15	1	4	..	1½	3	45	52	2,252	0	0	
Do. „ 5	15	1	4	..	1½	3	45	52	2,252	0	0	
Culvert No. 1	3	1	..	..	1	..	45	52	370	0	0	
Do. „ 2	3	2	..	..	1	..	45	52	465	0	0	

AQUEDUCT No. I.

Excavation for foundation in rock.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Abutments	2	20	8	2	640
Wing walls, right	2	45	6·50	2	1,170
Wing walls, left	2	42	6·50	2	1,092
Solid feet excavation in rock					2,902
Filling in foundation with uncoursed rubble masonry.					
Abutments	2	20	8	1	320
Wing walls, right	2	45	6·50	1	585
Wing walls, left	2	42	6·50	1	546
Solid feet filling in foundation					1,451
Superstructure of coursed rubble masonry.					
Abutments	2	19	7	8	2,128
Wing walls, right, mean height	2	45	4	15	5,400
Wing walls, left	2	42	4	15	5,040
			Area.		
Backing	2	13	18		468
Spandril walls	2	44	14	3·50	4,312
Total solid feet superstructure					17,348
Deduct.					
Segments of arches			Area.		
	2	268	3·5	....	1,876
Solid feet superstructure					15,472

Plastering.	Number.	Length.	Breadth.	Depth.	Square Feet.
Over arch	1	40	15	....	600
		Area.			
Spandrils	2	268		....	536
Parapets over the bridge	2	44	4·5	....	396
Do. over the wing walls	4	44	23	....	4,048
Square feet plastering					5,580

Arch-work.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Arch-work	1	19	40	2	1,520
Solid feet arch-work					1,520

Parapet walls.					
Over bridge	2	44	1·75	3	462
Over wings	4	44	1·75	5	1,540
Solid feet parapet walls					2,002

Filling in approaches and side embankments of channel, &c.					
Over the bridge	1	44	10	5·5	2,420
Between wing walls	2	39	27	16	33,696
			Area.		
Right approach	1	100	980		98,000
Left approach	1	100	980		98,000
Solid feet earthwork					232,116

Centering.	Number.
Centering for 30 feet span	1

ABSTRACT.

Quantities.	Items.	Amount. Rs. a. p.
2,902	Solid feet excavation in rock, at Rs. 6 per 100 solid feet.....	174 1 11
1,451	Solid feet filling in foundation, at Rs. 16 per 100 solid feet.....	232 2 6
15,472	Solid feet superstructure, at Rs. 20 per 100 solid feet.....	3,094 6 5
5,580	Square feet plastering, at Rs. 5 per 100 square feet	279 0 0
1,520	Solid feet archwork, at Rs. 50 per 100 solid feet	760 0 0
2,002	Solid feet parapet wall, at Rs. 30 per 100 solid feet	600 0 0
232,116	Solid feet earthwork, at As. 12 per 100 solid feet.....	1,740 12 0
1	Centering, at Rs. 300 each	300 0 0
	Total....Rupees	7,180 6 10
	Add contingencies at 5 per cent.....	359 0 4
	Establishment	240 0 0
	Total....Rupees	7,779 7 2

(Signed) J. G. FIFE, Lieut. Colonel, R.E.,
Superintending Engineer for Irrigation.

AQUEDUCT No. II.

Measurements.

Excavation for foundation in rock.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Abutments	2	21	5·00	2	420
Piers, including cutwaters, square	4	21	3·50	2	588
Wing walls, right	2	43·5	6	2	1,044
Do. left	2	33	4·5	2	594
Solid feet excavation in rock					2,646

Filling in foundation.					
Abutments	2	21	5	1	210
Piers, including cutwaters	4	21	3·5	1	294
Wing walls, right	2	43·5	6·5	2	1,131
Do. left	2	33	4·5	2	594
Solid feet filling in foundation					2,229

Superstructure, of coursed rubble with mortar.					
Abutments	2	19	4	4	608
Piers	1	21	2·5	6	315
	1	21	2·5	9	472·50
	1	21	2·5	9	472·50
	1	21	2·5	6·5	341·25
Wing walls, right	2	43·5	3·75	15	4,893·75
Ditto left	2	33	3	12	2,376·00
Spandril walls	2	93	2·	5	2,557·50
Head walls	2	93	2·5	1·5	465·00
			Area.		
Backing over piers	4	15	5		300·00
Do. over abutments	2	15	8		240·00
Solid feet superstructure					13,041·50

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Deduct.					
Segments of arches	5	Area. 50·66		19	4,812·70
Total solid feet superstructure					8,228·80

	Number.	Length.	Breadth.	Depth.	Square Feet.
Plastering.					
Over arches	5	18	15	....	1,350
		Area.			
Spandrils	2	213·70		....	427·40
Parapet walls	2	3	93	....	558
Do. over the wing walls	2	33	1·20	....	792
	2	43.50	15·00	....	1,305
Square feet plastering					4,432·40

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Arch-work.					
Arches	5	19·00	19·73	1·50	2,811·52
Solid feet arch-work					2,811·52

	Number.	Length.	Breadth.	Depth.	
Parapet wall.					
Parapet wall	2	93	1·75	3	976·5
Solid feet parapet wall					976·5

Earth-work.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Over the aqueduct.....	1	93	$\frac{5}{2}$	15	3,487·50
Between wing walls	1	38·5	8	27	8,316·00
Do. do.	1	28	8	27	6,048·00
			Area.		
Approaches.....	2	25	252·5		12,625·00
Solid feet earth-work.....					30,476·50

ABSTRACT.

Quantities.	Items.	Amount. Rs. a. p.
2,646	Solid feet excavation in rock, at Rs. 6 per 100 solid feet	158 12 2
2,229	Solid feet filling in foundation, at Rs. 16 per 100 solid feet	356 10 2
8,228·8	Solid feet superstructure, at Rs. 20 per 100 solid feet	1,645 12 2
4,432	Square feet plastering, at Rs. 5 per 100 square feet	221 9 7
2,812	Solid feet arch work, at Rs. 40 per 100 solid feet	1,124 12 9
976	Solid feet parapet wall, at Rs. 30 per 100 solid feet	292 12 9
30,476	Solid feet earth work, at As. 12 per 100 solid feet	228 9 1
3	Centerings, at Rs. 200 each.....	600 0 0
	Total....Rupees	4,628 14 8
	Add contingencies at 5 per cent.....	231 7 2
	Establishment	240 0 0
	Grand Total....Rupees	5,100 5 10

(Signed) J. G. FIFE, Lieut. Colonel, R.E.,
Superintending Engineer for Irrigation.

AQUEDUCT No. III.

Excavation for foundation in moorum and boulders.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Bed of nullah	1	41	300	5	61,500
Wing walls, right, 1st portion	2	15	4	6	720
Do. do. 2nd portion	2	18	4	4	576
Do. left, 1st do.	2	10	4	4	320
Do. do. 2nd do.	2	15	4	3	360
Solid feet excavation					63,476
Filling in foundation.					
Bedding below inverts	1	41	20	3·5	2,870
Wing walls, first and second portion, right	2	15	3	1	90
Ditto do. left	2	18	3	1	108
Ditto 1st do. do.	2	10	3	1	60
Ditto 2nd do. do.	2	15	3	1	90
					3,218
Deduct.			Area.		
Inverts	3	21	16		1,008
Solid feet filling in foundation					2,210
Superstructure.					
Abutments	2	21	3	3	252
Wing walls, right, 1st portion	2	15	2·5	13	975
Do. do. 2nd portion	2	18	2	10	720
Wing walls, left, 1st portion	2	10	2·5	11·5	575
Do. do. 2nd do.	2	15	2	8	480
Piers	2	23	2	2	184
Spandrils	2	40	2	4	640
			Area.		
Backing over abutments	2	19	8		272
Do. over piers	2	17	7		238
					4,336
Deduct	6	13	2		156
Solid feet superstructure					4,180

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Arch-work.					
Arches	3	21	11·5	1	724·50
Solid feet arch-work					724·50

	Number.
Centerings.	
Centering	3
Number of centerings	3

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Parapet wall.					
Parapet wall	2	40	2	3	480
Solid feet parapet walls					480

	Number.	Length.	Breadth.	Depth.	Running Feet
Coping.					
Over parapet walls	..	..	2	40	80
Do. wing walls	..	..	2	58	116
Total running feet coping					196

Plastering.					
Over bridge	..	1	40	22	880
Wing walls	..	2	58	6	696
Square feet plastering					1,576

Earth-work.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Over bridge	1	41	15	2	1,200
Do. wing walls	1	33	26	10	8,580
Right approach	1	200	56	4	44,800
Left approach	1	100	56	4	22,400
Solid feet earth work					76,980

Stone pitching.					
Right approach	1	200	3	2	1,200
Solid feet stone pitching					1,200

Inverts.					
Inverts	3	11	21	1	663
Solid feet invert arch-work					663

ABSTRACT.

Quantities.	Items.	Amount. Rs.	a.	p.
63,476	Solid feet excavation for foundation, at Rs. 2 per 100 solid feet	1,269	8	3
2,210	Solid feet filling in foundation, at Rs. 16 per do.	353	9	7
4,180	Do. superstructure, at Rs. 20 per do.....	836	0	0
725	Do. archwork, at Rs. 50 per do.....	362	8	0
3	Number of centerings, at Rs. 100 each	300	0	0
480	Solid feet parapet walls, at Rs. 30 per 100 solid feet	144	0	0
196	Running feet coping, at As. 8 per foot	98	0	0
1,576	Square feet plastering, at Rs. 5 per 100 square ft.	78	12	9
76,980	Solid feet earthwork, at As. 8 per 100 solid feet	384	14	4
1,200	Do. stone pitching, at Rs. 5 per 100 do.	60	0	0
663	Do. invert archwork, at Rs. 40 per 100 do.	265	3	2
	Total....Rupees	4,152	8	1
	Add contingencies at 5 per cent.....	207	10	0
	Establishment:—			
1	Carkoon for 6 months at Rs. 20 per mensem	120	0	0
1	Moocadum for do. at Rs. 10 per do.	60	0	0
	Total....Rupees	4,540	2	1

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Superintending Engineer for Irrigation.

AQUEDUCTS Nos. IV., VI., XII., and XIII.

Measurements.

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Excavation in rock.					
Cut in the rock	1	33	15	1·25	618·75
Wing walls	4	18	3	2	432·00
Solid feet excavation in rock					1,050·75
Filling in foundation.					
Wing walls	4	18	3	2	432
Solid feet filling in foundation					432
Superstructure.					
Wing walls	4	18	2·50	10	1,800
Backing	2	19	Area. 10		380
Solid feet superstructure					2,180
Arch-work.					
Arch	1	17	19	1·25	403
Solid feet arch-work					403
Parapet wall.					
Parapet wall	2	15	3	1·75	157·50
Solid feet parapet wall					157·50

Earth-work.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Between wing walls	2	13	27	3	2,430
Approaches.....	2	20	Area. 253·00		10,120
Solid feet earth-work.....					12,550

Plastering.	Number.	Length.	Breadth.	Depth.	Square Feet.
Arch	1	17	15	..	255
Parapet wall	2	15	3	..	90
Wing walls.....	4	18	10	..	720
Square feet plastering.....					1,065

ABSTRACT.

Quantities.	Items.	Amount. Rs.	a.	p.
1,050	Solid feet excavation in rock, at Rs. 6 per 100 solid feet	63	0	0
432	Solid feet filling in foundation, at Rs. 16 per 100 solid feet.....	69	1	11
2,180	Solid feet superstructure, at Rs. 20 per 100 solid feet	436	0	0
403	Solid feet archwork, at Rs. 40 per 100 solid feet.	*161	3	2
157	Solid feet parapet wall, at Rs. 30 per 100 solid feet.....	47	1	7
12,550	Solid feet earth work, at 12 annas per 100 solid feet.....	94	2	0
1,065	Square feet plastering, at Rs. 5 per 100 square feet	53	4	0
	Total....Rupees	923	12	8
	Add contingencies at 5 per cent.....	46	3	0
	Establishment.....	40	0	0
	Grand Total....Rupees	1,010	0	0

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Superintending Engineer for Irrigation

AQUEDUCT No. V.

MEASUREMENTS.

Excavation in rock.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Abutments	2	19	5	2	380
Piers, including cutwaters, square	4	21	4·5	2	756
Wing walls, right	2	49	9	3	2,646
Ditto left	2	54	8	3	2,592
Total solid feet excavation in rock					6,374

Filling in foundation.					
Abutments	2	19	5	1	190
Piers	4	21	4·5	1	378
Wingwalls, right	2	49	9	2	1,764
Ditto left	2	54	8	2	1,728
Total solid feet filling in foundation					4,160

Superstructure.					
Abutments	2	20	5	15	3,000·0
	4	21	4	16·5	5,460·0
Piers	2	49	6·5	25·5	14,293·5
Wing walls, right	2	54	6	24	15,552·0
Wing walls, left	2	93	2·5	5·5	2,557·5
Spandrils			Area.		
	2	15	8		240·0
Backing over abutments	4	15	5		300·0
Do. over piers	2	93	2·5	1	465·0
Head walls					41,868·0
Deduct	5	50·66	..	2·50	633·25
Solid feet superstructure					41,234·75

Arch-work.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Arches	5	18	19	1·25	2,137·5
Solid feet arch-work					2,137·5

Parapet wall.					
Parapet wall	2	93	1·75	3	976·5
Solid feet parapet wall					976·5

Plastering with lime.	Number.	Length.	Breadth.	Depth.	Superficial Feet.
Over arches	5	18	15	....	1,350·00
		Area.			
Spandrils	2	213·70		....	427·40
Parapet walls	2	4	93	....	744·00
Wing walls, right	2	49	25	....	2,450·00
Do. left	2	54	24	....	2,592·00
Square feet plastering					7,563·40

Earth work.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Over the aqueduct	1	93	2·50	15	3,487·5
Between wing walls	1	44	27	21	24,948
Do. do.	1	51	27	21	28,917
			Area.		
Approaches	2	100	980		196,000
Solid feet earth work					253,352·5

Centerings.	Number.
Number of centerings	3

ABSTRACT.

QUANTITIES.	ITEMS.	AMOUNT. Rs.	a.	p.
6,374	Solid feet excavation in rock, at Rs. 6 per 100 solid feet	382	6	10
4,160	Solid feet filling in foundation, at Rs. 16 per 100	665	9	7
41,868	Do. superstructure, at Rs. 20 per do. ..	8,373	9	7
2,137	Do. arch work, at Rs. 40 per do.	854	12	9
976	Do. parapet wall, at Rs. 30 per do.	292	12	9
253,352	Do. earth work, at 12 Annas per do.	1,900	2	2
7,563	Square feet plastering, at Rs. 5 per 100 square feet	378	2	4
3	Number of centerings, at Rs. 200 each.....	600	0	0
	Total....Rupees	13,447	8	0
	Add contingencies at 5 per cent....	672	6	0
	Establishment	240	0	0
	Total....Rupees	14,360	0	0

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AQUEDUCTS Nos. VII. AND VIII.

MEASUREMENTS.

	Number.	Length.	Breadth.	Depth.	SOLID FEET.
Excavation for foundation in rock.					
Abutments	2	20	6	3	720
Wing walls, right	2	44·5	5	3	1,335
Wing walls, left	2	38	4·75	3	1,083
Solid feet excavation in rock....					3,138
Filling in foundation with masonry.					
Abutments	2	20	19	1	760
Wing walls, right	2	44·5	5	2	890
Wing walls, left	2	38	4·75	2	722
Solid feet filling in foundation....					2,312
Superstructure.					
Abutments	2	19	4·5	10	1,710
Wing walls, right	2	44·5	4	16	5,696
Wing walls, left	2	38	375	15	4,275
Backing	2	8	1	14	256
Spandril wall	2	23	3	5¼	724·5
Head wall	2	23	3	1	138
					12,799·5
Deduct.					
Segments	2	50·66	2·50	....	253·3
Solid feet superstructure.....					12,546·2

Plastering.	Number.	Length.	Breadth.	Depth.	Square Feet.
Over arch	1	18	15	..	270
		Area.			
Spandril walls	2	70		..	140
Wing wall parapets, right and left together	2	44·5	7	..	623
Parapet walls	2	38	7	..	532
Square feet plastering					1,562

Arch-work.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Arch-work	1	18	19	1·25	427·5
Solid feet arch-work					427·5

Parapet walls.					
Parapet walls	2	23	1·75	3	241·5
Solid feet parapet walls					241·5

Earth work.					
Over the aqueduct	1	23	2·5	15	862·5
Between wing walls	2	40·5	8	7	5,136·0
		Area.			
Approaches	2	2,525·0		2·5	12,625
Solid feet earth work					18,623·5

ABSTRACT.

Quantities.	Items.	Amount. Rs. a. p.
3,138	Solid feet excavation in rock, at Rs. 6 per 100 solid feet	188 4 5
2,312	Solid feet filling in foundation, at Rupees 16 per 100 solid feet	369 14 8
12,546	Solid feet superstructure, at Rs. 20 per 100 solid feet	2,509 3 2
1,562	Square feet plastering, at Rs. 5 per 100 square feet	78 1 7
427·5	Solid feet arch-work, at Rs. 40 per 100 solid feet	171 0 0
241·5	Solid feet parapet walls, at Rs. 30 per do.	72 7 2
18,623	Solid feet earth-work, at 12 annas per do	139 10 9
	Total....Rupees	3,478 9 9
	Add contingencies at 5 per cent	173 14 11
	Establishment	180 0 0
	Grand Total....Rupees	3,832 8 8

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AQUEDUCT No. IX.

MEASUREMENTS.

Excavation for foundation in rock.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Abutments	2	20	5	3	600
Wing walls, right	2	23	3·5	3	483
Wing walls, left	2	21	3·75	3	472·5
Solid feet excavation for foundation....					1,555·5

Filling in foundation.					
For abutments	2	20	5	1	200
Wing walls, right	2	23	3·5	2	322
Wing walls, left	2	21	3·75	2	315
Solid feet filling in foundation.....					837

Superstructure of coursed rubble masonry in mortar.					
Abutments	2	19	4	3	456
Wing walls, right	2	23	2·5	10	1,150
Wing walls, left	2	21	2·75	11	1,170·50
Spandril walls	2	23	3	3	414
Head walls	2	23	3	1	138
Backing	2	8	1	15	240
Total solid feet superstructure					3,568·50

Deduct.		Area.		
Segments of arches	2	46·64	3	279·84
Solid feet superstructure				3,288·66

Arch-work.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Arch	1	18·33	19	1·25	435·33
Solid feet arch-work					435·33

Plastering.	Number.	Length.	Breadth.	Depth.	Square Feet.
Over the arch	1	20·33	15	..	304·95
Spandril	2	46·5		..	93·00
Wing walls	2	44	5	..	440·00
Parapet walls	2	23	3	..	138·00
Square-feet plastering					975·95

Earth work.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Over the bridge	1	23	1·5	15	517·5
Between wing walls	2	17	4	24	3,264
Approaches	2	10	50	4	4,000
Solid feet earth work					4,181·5 *

Parapet wall.					
Parapet wall	2	23	3	1·75	241·5
Solid feet parapets					241·5

* This appears inaccurate. (T. D.)

ABSTRACT.

Quantities.	Items.	Amount. Rs. a. p.
1,555	Solid feet excavation in rock, at Rs. 6 per 100 solid feet	93 4 9
837	Solid feet filling in foundation, at Rs. 16 per 100 solid feet	133 14 8
3,289	Solid feet superstructure, at Rs. 20 per 100 solid feet	657 12 9
435	Solid feet archwork, at Rs. 40 per do	174 0 0
976	Square feet plastering, at Rs. 5 per 100 square feet	48 12 9
241·5	Solid feet parapet wall, at Rs. 30 per 100 solid feet	72 7 2
4,181	Solid feet earthwork, at 12 annas per 100 solid feet	31 5 8
1	Centering, at Rs. 150 each	150 0 0
	Total ....Rupees	1,361 9 9
	Add contingencies at 5 per cent.	68 1 3
	Establishment	60 0 0
	Total Rupees for aqueduct No. 9....	1,489 11 0

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Superintending Engineer for Irrigation.

AQUEDUCT No. X.

Excavation for foundation.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Abutments	2	21	10	10	4,200
Piers	2	23	7	4	1,288
Wing walls, right	2	17	5	7	1,020
Do. do.	2	18	4	4	576
Do. left	2	17	5	8	1,360
Do. do.	2	20·5	4	3	492
Solid feet excavation					8,936

Filling in foundation.					
Abutments	2	20·5	8.5	2	697
Piers	2	23	5.5	2	506
Wing walls, right	2	17	5	1	170
Do. do.	2	18	4	1	144
Do. left	2	17	5	1	170
Do. do.	2	20·5	4	1	164
Solid feet filling in foundation					1,851

Superstructure.					
Abutments	2	19	7·50	15	4,275
Piers	2	22	4·5	15	2,970
Wing walls, right, 1st portion	2	17	4·5	17·5	2,677·5
Do. do. 2nd do.	2	18	3·5	13	1,638
Do. left, 1st do.	2	17	5·0	19	3,230
Do. do. 2nd do.	2	20·5	3·5	13	1,865·5
Spandrils	2	11·2	3	8	5,376
			Area.		
Backing over piers	2	17	27		918
Do. over abutments	2	17	16		544
Deduct—					23,494
			Area.		
Segments of arches	6		109	2	1,308
Solid feet superstructure					22,186

Arch-work.

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Arches	3	32·66	19	2	3,723·24
Solid feet arch-work					3,723·24

Plastering.

	Number.	Length.	Breadth.	Depth.	Square Feet.
Over bridge	1	112	22	....	2,464
Wing walls	2	72	8	....	1,152
Square feet plastering					3,616

Parapet wall.

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Parapet wall	2	112	3	2	1,344
Solid feet parapet wall					1,344

Coping, of cutstone.

	Number.	Length.	Breadth.	Running Feet.
Parapet wall	2	112	....	224
Wing walls	2	72	....	144
Running feet coping				368

Centering of arches.

	Number.
Under arches	3
Number of centerings	3

Approaches. Earth work.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Over aqueduct	1	112	2	15	3,360
Between wing walls	2	36	·26	5	9,360
Right and left approaches.....	2	40	226		18,080
Solid feet earth work.....					30,800

ABSTRACT.

Quantities.	Items.	Amount. Rs.	a.	p.
8,936	Solid feet excavation for foundation, at Rs. 3 per 100 solid feet	268	1	3
1,851	Solid feet filling in do., at Rs. 16 per do.	296	2	6
22,186	Do. superstructure, at Rs. 20 per do.	4,437	3	2
3,723	Do. archwork, at Rs. 50 per do.	1,861	8	0
3,616	Square feet plastering, at Rs. 5 per 100	180	12	9
1,344	Solid feet parapet wall, at Rs. 30 per 100.....	403	3	2
368	Running feet coping, at Annas 8 per foot.....	184	0	0
3	Number of centerings, at Rs. 300 each	900	0	0
30,800	Solid feet earth work, at As. 8 per 100 solid feet	154	0	0
	Total....Rupees	8,664	14	10
	Add contingencies at 5 per cent.....	434	3	11
	Establishment:—			
1	Carkoon for one year at Rs. 20 per mensem.....	240	0	0
2	Moocadums for do. at Rs. 10 per do.	240	0	0
	Grand Total....Rupees	9,599	2	9

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Superintending Engineer for Irrigation.

AQUEDUCT No. XI.

Excavation for foundation in rock.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Excavating bed	1	87	200	7	121,800
Wing walls	4	17	5	2	680
Solid feet excavation for foundation					122,480

Filling in foundation.					
Abutments	2	20	5	1	200
Piers	2	22	5	1	220
Wing walls	4	17	5	1	340
Solid feet filling in foundation					760

Superstructure.					
Abutments	2	19	5	5	950
Piers	2	22	3·75	10	1,650
Wing walls	4	17	5	13	4,420
Spandrils	2	87	2·5	7·5	3,262·50
			Area.		
Backing over abutments	2	15	27		810·00
Do. over piers	2	15	16		480·00
Total solid feet					11,572·50
Deduct—					
Segments of arches	2	109	2	..	436 } 996
Do. do.	4	70	2	..	560 }
Solid feet superstructure					10,576·50

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Arch-work.					
Centre arch	1	32·66	19	2	1,241·08
Side arches	2	24	19	1½	1,368
Solid feet arch-work					2,609·08
Parapet walls.					
Parapet walls	2	87	3	2	1,044
Solid feet parapet walls					1,044

	Number.	Length.	Breadth.	Depth.	Running Feet.
Coping, of cutstone.					
Parapet wall	2	..	..	87	174
Wing walls	4	..	..	17	68
Running feet coping					242

	Number.	Length.	Breadth.	Depth.	Square Feet.
Plastering.					
Over bridge	1	87	22	..	1,914
Wing walls	4	17	8	..	544
Square feet plastering					2,458

	Number.
Centering.	
Of mud	3
Number of centerings	3

Earth work in approaches.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Over bridge	1	87	15	2	2,610
Between wing walls	2	17	27	4	3,672
			Area.		
Right and left approaches	2	50	126		12,600
Solid feet earth work					18,882

ABSTRACT.

Quantities.	Items.	Amount. Rs.	a.	p.
122,480	Solid feet excavation in rock, at Rs. 4 per 100 solid feet	4,899	3	2
760	Solid feet filling in foundation, at Rs. 16 per 100 solid feet	121	9	7
10,576	Solid feet superstructure, at Rs. 20 per 100 solid feet	2,115	3	2
2,609	Solid feet archwork, at Rs. 50 per do.....	1,304	8	0
1,044	Do. parapet wall, at Rs. 30 per do.	313	3	2
242	Running feet coping, at 8 annas per foot.....	121	0	0
2,458	Square feet plastering, at Rs. 5 per 100 square feet	123	0	0
3	Number of centerings, at Rs. 200 each	600	0	0
18,882	Solid feet earth work, at 8 annas per 100 solid feet	94	6	6
	Total....Rupees	9,692	1	7
	Add contingencies at 5 per cent.	484	9	6
	Establishment :—			
1	Carcoon for 8 months at Rs. 20 per month.....	160	0	0
1	Moocadum for do. at Rs. 10 per do.	80	0	0
	Grand Total....Rupees	10,417	0	0

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Superintending Engineer for Irrigation.

ESTIMATE FOR CULVERTS Nos. I. AND II.

Excavation for foundation.

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Excavation for foundation below barrel	1	19	8	4	608
Wing walls	4	13	3	5	780
Solid feet excavation					1,388

Superstructure.

Below barrel	1	19	8	2	304
Wing walls, 1st portion	4	5	2	8	320
Do. 2nd portion	4	8	2	5	320
Over barrel	2	8	2	5	160
Solid feet superstructure					1,104

Plaster.

	Number.	Length.	Breadth.	Depth.	Square Feet.
Over barrel, including wing wall	1	....	34	8	272
Square feet plastering					272

Brick work.

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Barrel	1	19	Area. 13		247
Solid feet brick work					247

ABSTRACT.

QUANTITIES.	ITEMS.	AMOUNT.
		Rs. a. p.
1,388	Solid feet excavation for foundation, at Rs. 2 per 100 solid feet	27 12 11
1,104	Solid feet superstructure, at Rs. 20 per 100 solid feet	220 12 9
272	Square feet plastering, at Rs. 5 per 100 square feet	13 9 6
247	Solid feet brick work, at Rs. 30 per 100 solid feet	74 1 7
	Total....Rupees	336 4 9
	Add for contingencies and extra Establishment at 10 per cent.	33 10 0
	Cost for single culvert, Total....Rupees	370 0 0
	Cost of double barrel culvert .....Rs.	465 0 0

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Superintending Engineer for Irrigation.

OVER BRIDGES Nos. I. AND II.

MEASUREMENTS.

Excavation in rock.	Number.	Length.	Breadth.	Depth.	SOLID FEET.
Abutments	2	23	6	2	552
Wing walls	4	18·85	2·5	2	377
Solid feet excavation					929
Filling in foundation.					
Abutments, first	2	23	6	1	276
Do. second	2	22	5	1	220
Wing walls	4	18·85	2·5	1·50	282·75
Solid feet filling in foundation					778·75
Superstructure.					
Abutments	2	21	4	5	840
Wing walls	4	18·5	2	3	340
Spandril walls	2	23	2	4	368
Backing	2	17	8	1·5	408
					1,956
Deduct.					
For segments of arches	2	35	2	..	140
Solid feet superstructure					1,816
Arch-work.					
Arch	1	17	21	1¼	446¼
Solid feet arch-work					446¼

Parapet wall.

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Parapet wall	2	23	3	2	276
Solid feet parapet wall					276

Coping.

	Length.	Running Feet.
Rough cutstone over parapets	46	46
Do. do. over wing walls	75	75
Running feet coping		121

Centering.

	Number.
Centering of stone and mud	1

Approaches.

	Number.	Length.	Breadth.	Depth.	Solid Feet.
Right and left approaches	2	100	23	2·5	11,500
Between wing walls	2	12	29	5	3,480
Solid feet earth work					14,980

Laying down moorum.

Over bridge and approaches	1	245	18	1·5	2,205
Solid feet moorum					2,205

Metalling.

Same as moorum	1	245	18	1·5	2,205
Solid feet metal					2,205

ABSTRACT.

Quantities.	Items.	Amount.		
		Rs.	a.	p.
929	Solid feet excavation for foundation, at Rs. 6 per 100 solid feet	55	12	0
778	Solid feet filling in foundation, at Rs. 16 per 100 solid feet.....	124	11	0
1,816	Solid feet superstructure, at Rs. 30 per 100 solid feet	544	12	9
446	Solid feet archwork, at Rs. 50 per 100 solid feet	223	0	0
276	Solid feet parapet walls, at Rs. 40 per 100 solid feet	110	6	4
121	Running feet coping, at 8 annas per foot.....	60	8	0
1	Number of centering, at Rs. 150 each.....	150	0	0
14,980	Solid feet earth work, at Rs. 1 per 100 solid feet.	149	12	9
2,205	Solid feet moorum, at Rs. 1 per 100 solid feet.	22	0	9
2,205	Solid feet metal, at Rs. 5 per 100 solid feet ..	110	4	0
	Total....Rupees	1,551	3	7
	Add contingencies at 5 per cent....	77	9	0
	Establishment	60	0	0
	Grand Total....Rupees	1,689	0	0

(Signed) J. G. FIFE, Lieut. Colonel, R. E.,
Superintending Engineer for Irrigation.

OVER BRIDGES, Nos. III., IV., V.

Over-bridge for a roadway 18 feet wide is estimated to cost Rupees 1,689, hence for an over-bridge 24 feet wide, the cost is Rupees 2,252.

ABSTRACT.

	Rupees.
Over-bridge for a roadway 24 feet wide	2,252
Total....Rupees	2,252
Add for two more	4,504
Total Rupees for three over-bridges	6,756

GENERAL RECAPITULATION OF AQUEDUCTS, BRIDGES, AND CULVERTS.

No.	Description of work.		Amount.		
			Rs.	a.	p.
1	Canal, 11 miles and 1,436 yards, earth work		42,901	1	9
2	Aqueduct No. I.....	Sheet No. I.	7,779	7	2
3	Single culvert		370	0	0
4	Double ditto		465	0	0
5	Single ditto		370	0	0
6	Single ditto		370	0	0
7	Aqueduct No. II.		5,100	5	10
8	Ditto No. III.....	Sheet No. II.	4,540	2	1
9	Ditto No. IV.....		1,010	0	0
10	Ditto No. V.	Sheet No. III.....	14,360	0	0
11	Over-bridge No. I.		1,689	0	0
12	Aqueduct No. VI.		1,010	0	0
13	Single culvert.....	Sheet No. IV.	370	0	0
14	Double ditto		465	0	0
15	Aqueduct No. VII.....		3,832	8	8
16	Double culvert		465	0	0
17	Aqueduct No. VIII.....	Sheet No. V.	3,832	8	8
18	Ditto No. IX.		1,489	0	0
19	Over bridge No. II.		1,689	0	0
20	Aqueduct No. X.		9,599	0	0
21	Over-bridge No. III.		2,252	0	0
22	Aqueduct No. XI.		10,417	0	0
23	Ditto No. XII.		1,010	0	0
24	Ditto No. XIII.		1,010	0	0
25	Over-bridge No. IV.		2,252	0	0
26	Ditto No. V.		2,252	0	0
11	Modules, 11 in number, at Rs. 100 each		1,100	0	0
		Total....Rupees	1,22,000	0	0

DISTRIBUTING RESERVOIR.

The old quarry in front of Mr. Grant's shop and near the New Government Bakery is to be converted into a distributing reservoir, capable of holding one week's supply of water for the whole cantonment of Poona. This can be easily done by removing inequalities from the bottom of the quarry, building a retaining wall all round to a height 3 feet above the surrounding ground where necessary, and blocking up with masonry the present natural drainage feeder of the quarry. An outlet, with sluice gate of well seasoned teak wood will be provided at the bottom of the proposed reservoir, in case it requires cleaning.

The proposed reservoir commands the whole of the Cantonment except Wanowree, or southern portion. The highest point, near the upper storied barracks at Wanowree, is about 94 feet above the bottom of the proposed reservoir, and the water will be forced up by a steam engine, to be erected on the east side of the reservoir, close to the steam bakery. The daily supply of water to the rest of the Cantonment will be supplied by gravitation.

General Description.

The inequalities of rock at the bottom of the reservoir will be removed, and a slope to the bottom from east to west towards the proposed outlet, say about one in two hundred, will be given, to facilitate the cleaning of the reservoir. The position of the reservoir is such that the outlet will discharge waste water into the adjoining nullah. The superstructure of the retaining wall and outlet to be of coursed rubble masonry, with cutstone coping. Two semicircular cisterns, 20 feet diameter, to be attached to the reservoir. They are to correspond in depth with the reservoir, and the masonry to be of the same description. Pavements to be built round the cistern, and provision made by a small drain for leading the water that may be spilled to the adjoining nullah.

Measurements.

Removing rock.	Number.	Length.	Breadth.	Depth.	Solid Feet.
		Area.			
Bottom of the reservoir	1	76,850		2	153,700
Sides of ditto	1	1,067	1	10	10,670
Levelling rock for building retaining wall	1	1,069	2	1	2,138
Solid feet excavation in rock					166,508

Coursed rubble masonry for retaining wall and outlet.	Number.	Area.	Length.	Solid Feet.
Retaining wall	1	16	10·67	17,072
Outlet	1	24	20	480
Solid feet of superstructure				17,552

Flagging, over outlet.	Number.	Length.	Breadth.	Superficial Feet.
Over outlet	1	20	3	60
				60

Coping of retaining wall, of cutstone.	Number.	Length.	Running Feet.
Over retaining wall	1	1,067	1,067
Running feet of coping			1,067

Sluice gate, of Teak.	Number.
Teak wood gate	1

ABSTRACT.

Quantities.	Items.	Amount. Rs.	a.	p.
166,508	Solid feet excavation in rock, at Rupees 4 per 100 solid feet	6,660	5	1
17,552	Solid feet superstructure, of coursed rubble masonry, at Rupees 20 per 100 solid feet....	3,510	6	6
60	Square feet stone flagging, at Annas 3 per square foot	11	4	0
1,067	Running feet coping at Annas 8 per running foot	533	8	0
1	No. sluice gate, at Rs. 50 each	50	0	0
	Total....Rupees	10,765	7	7
	Contingencies at 5 per cent.....	538	4	5
	Extra Establishment:—			
2	Carcoons for 8 months, at Rs. 20 per month	320	0	0
4	Moocadums for 8 months, at Rs. 10 per month..	320	0	0
	Total for Reservoir....Rs.	11,943	12	0

(Signed) J. G. FIFE, Lieut. Colonel, R.E.,
Superintending Engineer for Irrigation.

CAMP DISTRIBUTION.

General Description.

The retaining walls of the cisterns to be built of coursed rubble masonry, with a cutstone facing on the inside; a parapet wall of cutstone to surround the cistern at the top, and a cutstone pavement to be constructed outside. The iron pipes conveying the water from the distributing reservoir to be of the kind usually denominated socket pipes; to be perfectly sound and free from cracks and flaws, or other defects in the casting, with stand pipes and stop cocks provided for each cistern. The details of the Camp distribution are shown in Plan.

Measurements.

Excavation for cisterns, 25 feet by 18 feet by 8 feet.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Cistern	1	31	24	9	6,696·00
Paving	1	123⅓	5	1	616·66
Solid feet excavation					7,312·66
Half of this excavation is in moorum					3,656·33
Half do. do. in rock					3,656·33
Retaining wall.					
First portion	1	98	3	1	294
Second portion	1	96	2·5	2	480
Third portion	1	94⅔	2⅙	2	473·33
Fourth portion	1	93⅓	1⅚	2	342·22
Fifth portion	1	92	1·5	2	276·00
Solid feet of retaining wall					1,865·55

Cutstone masonry.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Parapet wall	1	$91\frac{1}{3}$	$1\frac{1}{3}$	$2\frac{3}{4}$	334·88
Solid feet cutstone work on both sides, including coping..					334·88

Paving.	Number.	Length.	Breadth.	Square Feet.
Bottom of cistern	1	25	18	450·00
Outside the parapet of cistern	1	124	6·5	806·00
Square feet cutstone paving				1,256·00

Cistern, 15 feet by 10 feet by 8 feet. *Excavation for cistern.*	Number.	Length.	Breadth.	Depth.	Solid Feet.
Cistern	1	21	16	9	3,024
Paving	1	94	5	1	470
Solid feet excavation					3,494
Half excavation for small cistern in moorum....					1,747
Half do. do. in rock					1,747

Retaining wall.					
First portion	1	62	3	1	186·00
Second portion	1	62	$2\frac{1}{6}$	2	300·00
Third portion	1	$58\frac{2}{3}$	$2\frac{1}{8}$	2	254·22
Fourth portion	1	$57\frac{1}{6}$	$15\frac{1}{6}$	2	210·22
Fifth portion	1	56	$1\frac{1}{2}$	2	168·00
Solid feet coursed rubble masonry, faced with cutstone on both sides					1,118·44

Cutstone masonry.	Number.	Length.	Breadth.	Depth.	Solid Feet.
Parapet wall	1	55⅓	1⅓	2¾	202·88
Solid feet cutstone on both sides, including coping					202·88

Paving.	Number.	Length.	Breadth.	Square Feet.
Bottom of the cistern	1	15	10	150
Outside the parapet of the cistern	1	88	6·5	572
Total square feet cutstone paving.....				722

Distributing main, and branch pipe.	No.	Length.	Weight. Tons	Cwt.	Qrs.	Lbs.
⅝ inch main pipe, 14 inches diameter, including breakage, spigots, and faucets.....	1	42,000	186	1	0	11
½ inch branch pipe, 6 inches diameter, and do.	1	8,320	131	13	0	14
½ inch branch pipe, 5 inches diameter, and do.	1	12,600	158	0	2	4
½ inch branch pipe, 4 inches diameter, and do.	1	17,293	189	11	3	24
Total running feet, and weight		42,418	665	6	2	25

ABSTRACT.

Quantities.	Items.	Amount. Rs.	a.	p.
	Cistern, 25 feet by 18 feet by 8 feet.			
3,656	Solid feet excavation in moorum, at Rs. 2 per 100 solid feet	73	0	0
3,656	Solid feet in rock, at Rs. 4 per 100 solid feet	147	0	0
1,865	Solid feet superstructure, at Rs. 40 per ditto	746	0	0
335	Solid feet cutstone parapet, at Rs. 1 per foot	335	0	0
1,256	Square feet paving, at Rs. 40 per 100 square feet.	502	0	0
	Total....Rupees	1,803	0	0
	Contingencies at 5 per cent	90	0	0
	Total Rupees for 25 feet by 18 feet by 8 feet cistern	1,893	0	0

	Cistern, 15 feet by 10 feet by 8 feet.			
1,747	Solid feet excavation in moorum, at Rs. 2 per 100 solid feet	35	0	0
1,747	Solid feet in rock, at Rs. 4 per ditto	70	0	0
1,118	Solid feet superstructure of retaining wall, faced with cutstone, at Rs. 40 per 100 solid feet	447	0	0
203	Solid feet cutstone masonry for parapet wall, including coping, at Rs. 1 per foot	203	0	0
722	Superficial feet cutstone paving for parapet, including coping, at Rs. 40 per 100 superficial feet	289	0	0
	Total....Rupees.	1,044	0	0
	Contingencies at 5 per cent	52	0	0
	Total Rupees for a cistern 15 feet by 10 feet by 8 feet	1,096	0	0

ABSTRACT—*continued.*

Quantities.	Items.	Amount. Rs.	a.	p.
665⅓	Tons of cast iron pipe at Rs. 150 per ton.....	1,06,453	0	0
42,418	Running feet laying pipe at Rs. ¼ per running foot	10,604	0	0
		1,17,057	0	0
	Contingencies at 5 per cent....	5,853	0	0
	Total....Rupees	1,22,910	0	0

GENERAL ABSTRACT.

		Rs.	a.	p.
22	Large Cisterns, 25 feet by 18 feet by 8 feet, at Rs. 1,893 each.....	41,646	0	0
10	Small ditto, 15 feet by 10 feet by 8 feet, at Rs. 1,096 each	10,960	0	0
	Piping	1,22,910	0	0
	Total.....Rupees	1,75,516	0	0
4	Carkoons for one year at 20 Rupees per mensem....	960	0	0
8	Moocadums at 10 Rupees per mensem, for one year.	960	0	0
	Grand Total....Rs.	1,77,436	0	0

EXPENSES of Working of the Steam Engine, Capitalized at 5 per cent., including cost of the Engine and Engine Shed.

Miscellaneous Works.	Number.
Engine of 6 horse power, including pumping apparatus.....	1
Engine shed.....	1
Expenses of working the engine capitalized.....	1

ABSTRACT.

Quantities.	Items.	Amount. Rs.	a.	p.
1	No. of engine of 6 horse power, at Rs. 6,000 ..	6,000	0	0
1	No. of engine shed	3,000	0	0
	Annual expenditure for working the engine capitalized	85,600	0	0
	Total .....Rupees	94,600	0	0

Annual Expenses for Working Engine.

		Rs.	a.	p.
98	Tons of coals, at Rs. 30 per ton.....	2,940	0	0
	Tallow, oil, hemp, &c.	600	0	0
2	Native Calassees at Rs. 10 per month	240	0	0
	Repairs to engine and engine shed	500	0	0
	Total Expenditure per annum....	4,280	0	0
	Expenditure capitalized at 5 per cent.....	85,600	0	0

RECAPITULATION.

		Rs.	a.	p.
1	Settling Reservoir	11,943	12	0
1	Distributing Reservoir, to hold one week's supply	11,943	12	0
1	Distribution throughout the Camp	1,77,436	0	0
1	Cost of engine, engine shed, and annual expenses for working it, capitalized	94,600	0	0
	Grand Total....Rupees	2,95,923	8	0

(Signed) J. G. FIFE, Lieut. Colonel, R.E.,
Superintending Engineer for Irrigation.

GENERAL RECAPITULATION

OF

Poona and Kirkee Water Supply Project.

	Rs.	a.	p.
Cost of land	77,800	0	0
Dam	7,52,710	2	4
Waste weir	74,886	11	1
Wing wall	46,725	1	4
Settling and expense reservoir, at Gunesh Khind	16,642	3	1
Kirkee duct	31,390	13	8
Main pipe	1,06,831	8	4
Kirkee Cantonment distribution	24,795	0	0
Distribution in the Powder Works	56,277	0	0
Aqueduct, No. 1	1,475	12	7
Ditto No. 2	3,395	15	6
Ditto Nos. 3, 5, 8, 12, 16, 17, 19	9,621	8	0
Ditto Nos. 4, 7, 9, 14, 20, 21	12,099	15	6
Ditto No. 6	2,524	3	1
Ditto No. 10	2,114	7	6
Ditto Nos. 11, 15, 18	2,550	1	9
Ditto No. 13	1,456	10	4
Culvert, 5 feet span, No. 12	8,545	4	0
Slab drains, 3 × 3, of 2 openings, No. 5	1,240	8	4
Syphon drain of one opening, No. 10	1,093	14	10
Road bridge	949	3	3
Poona duct, and masonry works on it, as per table, page 171	1,22,900	2	2
Settling reservoir	11,943	12	0
Distributing reservoir	11,943	12	0
Camp distribution	1,77,436	0	0
Cost of engine, engine shed, and annual expenses for working it, capitalized	94,600	0	0
Rupees	16,53,049	10	8

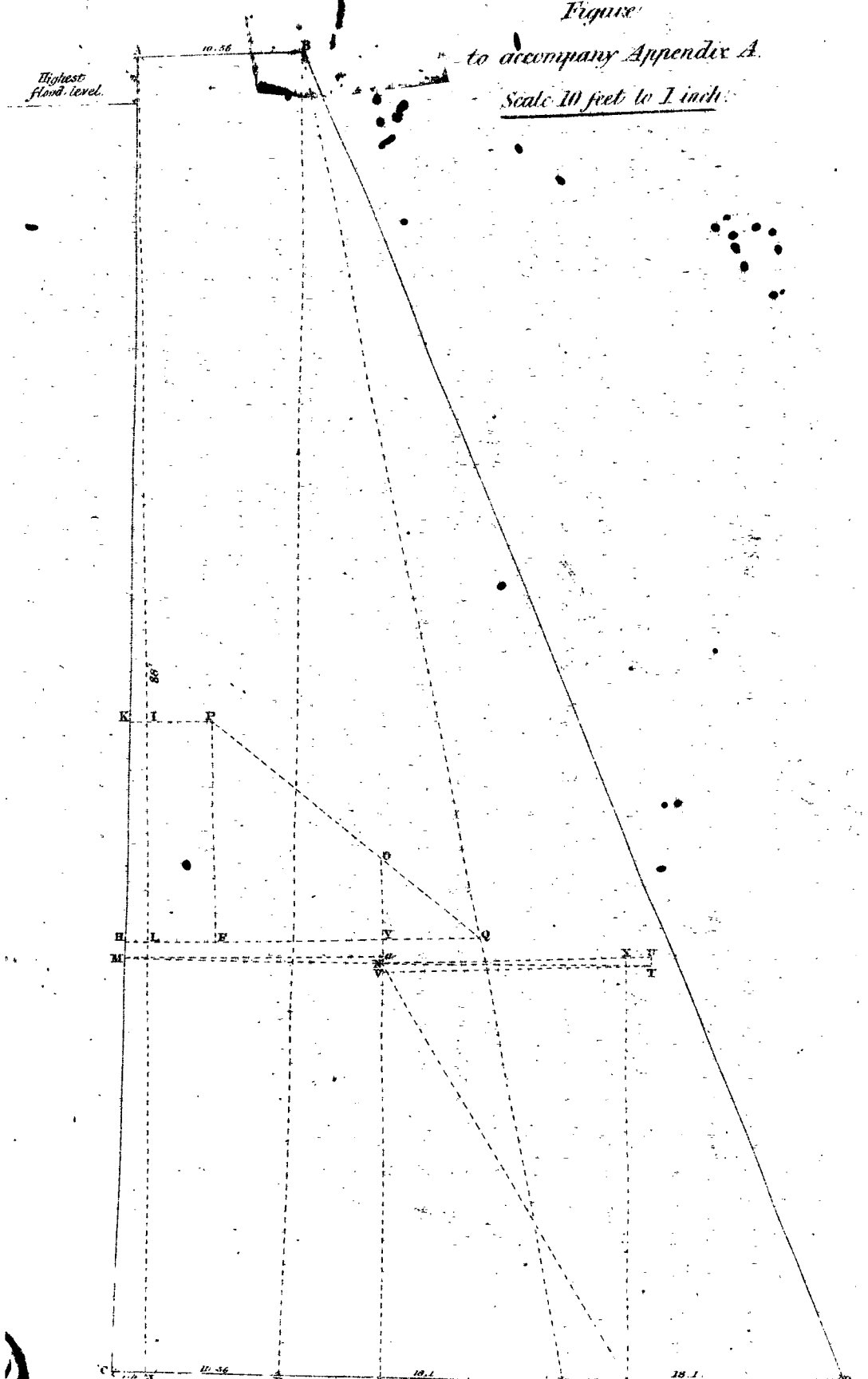
C. SCOTT, Lieut Colonel, R.E.,
Superintending Engineer, Southern Division.

(Signed) J. G. FIFE, Lieut. Colonel, R.E.,
Superintending Engineer for Irrigation.

Figure

to accompany Appendix A.

Scale 10 feet to 1 inch.



APPENDIX A

TO LIEUT. COLONEL FIFE'S LETTER.

CALCULATIONS showing the Stability of the Masonry Dam across the River Moota.

Extreme depth or head of water, during heaviest flood, 85 feet.

Height of Dam, without parapet, 88 feet.

Thickness at base = 0·55 of head of water.

Thickness at highest water, or flood level, = 0·25 of thickness at base.

Batter on water face = $\frac{1}{20}$th of height.

Batter on rear face = $\frac{4}{11}$ths of height.

Weight of one cubic foot of water = 62·32 lbs.

Weight of one cubic foot of masonry = 150 lbs.

First, to find the centre of gravity of the figure.

The centre of gravity of the paralellogram ABEC is at P its centre and 44 feet, or half the whole height, from the base.

The centre of gravity of the triangle BED is at Q, which is one-third of the whole height, or 29·33 feet from the base.

Join PQ, and through Q draw the horizontal line HQ; from P let fall the perpendicular PF to meet HQ in F.

Then to fix the position of O, the centre of gravity of the whole mass of masonry, we have

$$PO \times ABEC = QO \times BED$$
$$= (PQ - PO)\ BED \quad (1)$$

By finding the value of PQ, and the areas of ABEC and BED, we shall obtain the value of PO, and then of OQ.

$$\text{Now PQ} = \sqrt{\text{PF}^2 + \text{FQ}^2} = \sqrt{\left(\frac{\text{AJ}}{2} - \text{JL}\right)^2 + (\text{HQ} - \text{HF})^2}$$

$$= \sqrt{(44 - 29{\cdot}33)^2 + (10{\cdot}56 + \tfrac{6}{5}\,18{\cdot}1 - \{\text{HL} + \text{IP}\})^2}$$

$$= \sqrt{(14{\cdot}66)^2 + (22{\cdot}62 - \{\tfrac{6}{5} \times 4{\cdot}4 + ((\text{KP} - \text{KI}))\})^2}$$

$$= \sqrt{(14{\cdot}66)^2 + (22{\cdot}62 - \{2{\cdot}93 + \tfrac{1}{2} \times 10{\cdot}56 - \tfrac{1}{5} \times 4{\cdot}4\})^2}$$

$$= \sqrt{214{\cdot}91 + (22{\cdot}62 - 6{\cdot}01)^2}$$

$$= \sqrt{214{\cdot}91 + 275{\cdot}89}$$

$$= \sqrt{490{\cdot}8} = 22{\cdot}15$$

Next the area of ABEC $= 10{\cdot}56 \times 88$
$= 929{\cdot}28$
and the area of BED $= 18{\cdot}1 \times 88$
$= 1592{\cdot}80$

Substituting the values now found in equation (1), we have

$$\text{PO} \times 929{\cdot}28 = (22{\cdot}15 - \text{PO})\ 1592{\cdot}8$$
$$2522{\cdot}08 \times \text{PO} = 35280{\cdot}52$$
$$\text{PO} = 13{\cdot}98$$
$$\text{and OQ} = \text{Q} - \text{PO}$$
$$= 22\,15 - 13{\cdot}98$$
$$= 8{\cdot}17$$

The weight of the whole mass of masonry, assuming that one foot in length of the dam is taken into consideration, will be

$$2522{\cdot}08 \times 1 \times 150 \text{ lbs.}$$
$$= 378312{\cdot}00 \text{ lbs.} = \text{W.}$$

and it may be supposed to act at N in the vertical line dropped from the centre of gravity of the whole mass, O. The pressure of the water will be

$$85{\cdot}1 \times 42{\cdot}5 \times 62{\cdot}32 \text{ lbs.}$$
$$= 225395{\cdot}86 \text{ lbs.}$$

and will act at M, at a distance of one-third of the whole depth from the bottom, and in a direction perpendicular to the face of the wall.

This force may be supposed to act at N, where its direction is intersected by the vertical ON.

To facilitate the working out of the result, resolve the pressure of the water, which may be called P, into two forces; one, W, vertical; the other, P, horizontal, at N.

Complete the parallelogram NVTU.

Then $NV = TU = NT \sin TNU$.

Now $\sin TNU = \sin CAJ = \frac{4{\cdot}4}{88{\cdot}14}$

$= 0{\cdot}05$

Therefore $NV = 0{\cdot}05 \times 225395{\cdot}86$

$= 11269{\cdot}79 = W.$

and $NU = P^1 = \sqrt{(225395{\cdot}86)^2 - (11269{\cdot}79)^2}$

$= 225113{\cdot}93.$

The forces acting at N will thus be $W + w$ in the direction of the vertical os, and P^1 in the direction NU.

Complete the parallelogram NSRX, making NS and NX proportional to the forces $W + w$, and P^1 respectively.

$$W + w = 378312{\cdot}00 + 11269{\cdot}79.$$
$$= 389581{\cdot}79$$
$$\text{and } P^1 = 225113{\cdot}93$$

Now $SN : SR :: W + w : P^1$.

$:: 389581{\cdot}79 : 225113{\cdot}93$

$$\therefore SR = \frac{SN \times 225113{\cdot}93}{389581{\cdot}79}$$

and $SN = SY - NY = 29{\cdot}33 - (Ya + aN)$

$= 29{\cdot}33 - (1 + aN)$

Again $aN = \frac{1}{20} \times aM = \frac{1}{20}(HF + FY + \frac{1}{20} \times 1)$

$= \frac{1}{20}(5{\cdot}28 + \frac{44 - 29{\cdot}33}{20} + FY + \frac{1}{20})$

and $FY : FQ :: PO : PQ$

$$\therefore FY = \frac{FQ \times PO}{PQ} = \frac{16{\cdot}61 \times 13{\cdot}98}{22{\cdot}15}$$

$= 10{\cdot}48$

$\therefore aN = \frac{1}{20}(5{\cdot}28 + 0{\cdot}733 + 10{\cdot}48 + 0{\cdot}05)$

$= \frac{16{\cdot}543}{20} = 0{\cdot}8271$

$$\therefore \text{SN} = 29{\cdot}33 - (1 + 0{\cdot}8271)$$
$$= 29{\cdot}33 - 1{\cdot}8271 = 27{\cdot}51$$

$$\text{and SR} = \frac{\text{SN} \times 225113{\cdot}93}{389581{\cdot}79}$$
$$= \frac{27{\cdot}51 \times 225113{\cdot}93}{389581{\cdot}79}$$
$$= 15{\cdot}63$$

$$\text{Now CS} = \text{HY} + \tfrac{1}{20} \times \text{SY} = \text{HF} + \text{FY} + \frac{29{\cdot}33}{20}$$
$$= 6{\cdot}013 + 10{\cdot}48 + 1{\cdot}466$$
$$= 17{\cdot}959$$

$$\text{and CZ} = \tfrac{1}{2}\,\text{CD} = \frac{46{\cdot}75}{2} = 23{\cdot}375$$

$$\therefore \text{SZ} = 23{\cdot}375 - 17{\cdot}959 = 5{\cdot}416$$

$$\text{and ZR} = \text{SR} - \text{SZ} = 15{\cdot}63 - 5{\cdot}41$$
$$= 10{\cdot}22$$

The resultant R, therefore, passes through the base at a little less than one-fourth the width of the base, which is 11·69 from its centre.

Rankine, who is perhaps our best authority on the subject of the stability of retaining walls or dams, says that except when the foundation is rock, one-fourth of the width of the base from the centre is the limit for the resultant, but that in the case of a very firm foundation this limit may be exceeded. It has, however, been thought advisable to give the dam for the Moota Reservoir some extra strength, and the resultant passes even within the limit laid down by Rankine for a dam on an ordinary foundation, though the Moota Dam will be founded on rock.

No credit, moreover, has been taken for the aid that will be obtained from the bank of earth which will be heaped against the dam on both sides to check leakage.

The weight of a cubic foot of masonry has been obtained by actual experiment on rubble stone walling at Poona.

APPENDIX B.

CALCULATIONS to show that the Waste Weir, as designed, is capable of carrying off a quantity of water equal to the discharge of the River Moota during the greatest known flood.

The greatest flood remembered by the inhabitants of the village of Kopreh, close to the dam site, occurred in 1861, and from information obtained from the people, it has been calculated that the discharge of the river on that occasion was 82,079 cubic feet per second.

The waste weir must therefore be of sufficient dimensions to carry off at least that quantity of water.

The length of the waste weir, when the water is passing over its crest at a depth of five feet, is 1,658 feet. Of this length 990 feet is more than 10 feet high, and consequently has a clear overfall of 5 feet. The remaining portion, 668 feet in length, is less than 10 feet high, and is consequently drowned to a probable average depth of 2 feet 6 inches.

The discharge of the waste weir, when water is going over its crest at a depth of 5 feet, is therefore as follows :—

For the first portion,

$$\text{Discharge} = 990 \times 5 \times 12\tfrac{1}{2}^{*}$$
$$= 61{,}875 \text{ cubic feet per second.}$$

For the second portion,

$$\text{Discharge} = 668 \times 5 \times 10\tfrac{1}{1\,2}^{*}$$
$$= 36{,}461 \text{ cubic feet per second.}$$

$$\text{Total discharge} = 98{,}336 \text{ cubic feet per second.}$$

The discharge of the river during the greatest known flood being 82,079 cubic feet per second, the waste weir is capable of carrying off, 98,336,—82,079 = 16,257 cubic feet per second in excess of what is likely to be required of it.

* Vide Neville's Hydraulic tables.

APPENDIX C.

TABLE showing the cost of the water supply of Poona and Kirkee, as regards pay of Bheesties, Working of Wells, Pumping Machinery, Impounding Water, &c., for the year 1864.

Locality.	Public Works Department.	The Quarter Master General's, or Military Department.	Commissariat Department.	Total Rupees.	Average of the last three years.
	Rs. a. p.	Rs. a. p.	Rs. a. p.		
Kirkee ..					
Gorpoorie.	3,174 9 10	2 1,54 3 0	4,824 0 0		
Poona.. ..				41,294 12 10	36,130
The Bund Waterworks ..	11,750 0 0				

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